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JPRS-UEN-85-004

7 February 1985

USSR REPORT

ENERGY

CONTENTS

FUELS

OIL AND GAS

[III - USSR - 37]

C

PIPELINES

PIPELINE CONSTRUCTION

COMPRESSOR STATIONS

OIL AND GAS

UDC 553.981 (477.6)

GAS ACCUMULATIONS PREDICTED IN DNIEPR-DONETS DEPRESSION

Kiev NEFTYANAYA I GAZOVAYA PROMYSHLENNOST' in Russian No 3, Jul-Sep 84 pp 1-3

[Article by Ya. I. Kolomiets, B. P. Sterlin and O. E. Yakovlev, UkrNIIgaz (Ukrainian Scientific-Research Gas Institute) and Ukrburgaz Production Association: "Commercial Gas in Lower Permian Bubble Trains of the Southeastern Part of the Dniepr-Donets Depression"]

[Text] Analysis of the geological structure of stock zones of the Chutovo-Belukhovskiy salt swell [1], which is contiguous with the Chutovskoye, Novoukrainskoye and Raspashnovskoye gas-condensate and gas-condensate-oil deposits, made it possible to reveal a type of gas deposits previously unknown in the region and associated with bubble trains of Devonian salt bodies.

These formations were formed in the Early Permian as a result of submarine denudation and dissolution of salt stocks. As a result of this, the fragments of carbonate, terrigenic and effusive rock fragments were concentrated in the form of wedge-shaped seams near the salt bodies. Bubble trains in the southeast of the Dniepr-Donets depression were described in [2]; however, their gas content was unknown.

Investigation of a vast amount of core and geophysical material obtained from boreholes drilled by the Ukrainian SSR Ministry of Geology at the Novoukrainskoye and Chutovskoye deposits made it possible to establish the age and genesis of Lower Permian deposits surrounding gas accumulations near salt bodies.

The Lower Permian deposits in the Novoukrainskoye and Chutovskoye deposits are deeply eroded into blocks of the Turneyskiy and Bashkirskiy stages, and they are covered by a stock "overhang" up to 3,500 m thick.

Stock cross sections differ significantly from the well-developed normal marine Lower Permian salt deposits of the Dniepr-Donets depression. First of all the thickness of anhydrites decreases significantly and seams of rock salt disappear completely near the stocks, in connection with which the cycles of sediment accumulation typical of the carbonate-halogen strata of the Dniepr-Donets depression formed in the open sea are not pronounced in the cross sections. Therefore it is difficult or impossible to distinguish the datum horizons of the Nikitovskaya and Slavyanskaya suites.

Investigation of the material composition of Lower Permian sediments in the Novoukrainskoye (wells No 21,22,31,32) and Chutovskoye (wells No 6,27) deposits demonstrated that their structure is dominated by rock characteristic of bubble train strata.

Bubble trains of the Novoukrainskoye deposit consist primarily of carbonates--limestone and dolomite varying in color from grayish white to dark gray, varying in granularity and containing inclusions of carbonified plant remains, anhydrite and argillite. The rock is often nodular, porous and cavernous. They are relatively indistinguishable macroscopically from the rock of carbonate horizons from a normal salt-bearing Lower Permian cross section.

A significant difference can be noted between normal and bubble train carbonates beneath a microscope. The latter appear as small nodules, clusters, pseudo-oolites and oolites; there are traces of terrigenic material containing idiomorphic crystals of quartz, dolomite and calcite, pyrite phenocrysts, magnetite grains and fragments of Devonian diabase.

Active authigenic mineral formation in rock occurs owing to presence, among the formed sediments, of salt bodies that alter the hydrochemical conditions of bottom and subterranean buried waters.

Complete absence of organic remains is typical of the kinds of bubble train rock considered here. Attached foraminifers exhibiting an extensive vertical distribution and shell-forming organisms such as stromatolites are encountered very rarely.

The thickness of the bubble train cross section in the deposit is 120-180 m. Brown, gray and dark gray argillite and clay characterizing normal sediment accumulation can be seen together with anhydrite seams (0.5-1 m thick) in its lower half. Dark gray carbonaceous argillite and clay neighboring with anhydrite is typical of the upper part of the Melikhovskaya stratum of the Kartamyshskaya suite (the first anhydrite encountered above limestone layer Q_7) and the lower part of the Lower Permian Nikitovskaya suite, which together with the conditions under which these formations occur is evidence of the time at which this rock formed.

The Lower Permian bubble train of the Chutovskoye deposit consists of alternating layers of carbonate and terrigenic rock. The latter is represented by aleurolite, sandstone and gritstone. Sandstone and gritstone on carbonate cement contains fragments of silicon, anhydrite, argillite, diabase and spilite, quartz grains and isolated oolites. Numerous neoformations are developed on the background of the heterogeneous mass: quartzine rosettes, carbonate crystals, islands of aggregated anhydrite and magnetite grains. The thickness of individual seams in the terrigenic rock is 10-30 m.

Limestone consists of oolites and pseudo-oolites together with fragments of modified diabase and spilite that often serve as nuclei for oolites. Gradual transition of carbonate into gritstone may be observed on occasion in the core.

The total thickness of the bubble train cross section of the Novoukrainskoye and Chutovskoye deposits attains 200-400 m (wells No 21,6), which served as one of the grounds for concluding that it has a reef origin [3].

As was noted above, commercial accumulations of gas were revealed in bubble train formations of the Novoukrainskoye and Chutovskoye deposits.

Dolomite and limestone with core-determined porosity of 12-20 percent are the reservoirs of the bubble train stratum of the Novoukrainskoye deposit. The reservoirs occur amid dense carbonate rock in the form of lenses 1-25 m thick oriented along the long axis of the salt body. The dynamic gas transmissivity of these lenses is poor. The total thickness of gas-bearing reservoirs in the cross section of individual bore-holes attains 70 m. The reservoir properties of bubble train carbonate and correspondingly its productivity vary rather abruptly in bearing. Thus the gas yield from wells No 21 and 31 in the central and northwestern parts of the deposit was 10.3 (46 mm washer) and 2.9 million m^3/day (35 mm washer) respectively. The initial reservoir pressure at a depth of 3,627 m was 41.89 MPa. The storage capacity and filtration properties of bubble train carbonate rock deteriorate significantly in the southeastern section. The gas yield from well No 22, drilled 1.8 km away from well No 21, was only 8,100 m^3/day (8.1 mm washer). About 1 km away from the stock the gas-bearing formations are substituted by dense rock representing the normal salt-bearing cross section of the carbonate-halogen stratum.

Practically the entire thickness of the bubble train is productive in well No 6 (2,500-2,900 m interval) in the Chutovskoye deposit. Here both terrigenic and carbonate rock contains gas. Core-determined porosity is 16.2-29.7 percent for limestone, 7-15 percent for sandstone and 10.6-20.3 percent for gritstone. The well's gas yield from five proven formations in the bubble train varies from 74,000 to 207,000 m^3/day. Reservoir pressure is 34.38 MPa at a depth of 2,822 m. According to oil field geophysical data and sampling data, the total effective gas-saturated thickness of bubble train deposits attains 200 m, and the width of their development is 1.1 km.

It should be noted that the carbonate horizon S_3 of the Slavyanskaya suite, which is 30-35 m thick, is productive in the southern part of the Chutovskoye deposit, where the Lower Permian cross section is normally developed. In terms of gas dynamics it is isolated from the gas-bearing seams of bubble train deposits, as is evidenced by differences in the reservoir pressures recorded in them at the same hypsometric elevation.

Gas-bearing bubble train formations are not controlled by structural forms, and lithologically they are shielded from all sides. Above, salt stock overhangs serve as a cap, partially playing the role of lateral shields. On the other hand in zones where bubble train sections are substituted by normal salt sections, the gas-bearing reservoirs are confined by dense carbonate, clay, anhydrite and salts. Clay and anhydrite seams of the lower half of the Nikitovskaya suite underlying the bubble trains shield the gas accumulation from below. Active bed or perimeter water was not detected in bubble train accumulations.

Besides in the Chutovskoye and Novoukrainskoye deposits, gas-bearing formations similar to those described above were encountered in Lower Permian carbonate sediments in the Krestishchenskoye deposit, in a narrow zone within which they are continguous with a salt stock of the same name (wells No 283,323,128 and others).

The data presented above on the conditions under which gas-bearing bubble trains occur permit us to treat these gas formations, in accordance with the classification suggested by Brod and Yeremenko [4], as lithologically confined from all sides.

Significant height (up to 400 m) and modest width (up to 1 km) are typical of this type of accumulations.

The reservoirs of bubble train accumulations formed in coastal marine conditions. Evidence of this can be found in the oolite and pseudo-oolite structure of carbonates, the attached forms of foraminifers and the absence of salt seams. In all probability the Chutovsko-Belukhovskiy swell and its marginal zone were elevated in the Early Permian Period, and they were reflected in the bottom topography of the sea basin as rises of considerable amplitude.

These data provide the grounds for believing that natural reservoirs containing gas in Lower Permian sediments in the Chutovskoye, Novoukrainskoye and Krestishchenskoye deposits owe their origin almost exclusively to salt stocks. The latter are a source of fragmented material, including carbonate material, out of which a significant part of the reservoirs were formed. Moreover owing to growth of the stocks, special conditions for sediment formation were created in their marginal zones.

But growth in thickness of a carbonate seam in Slavyanskaya and Nikitovskaya suites is far from always the product of bubble train formation; often in these cases a different mechanism operates (formation of carbonate banks, according to O. E. Yakovlev and others). In particular bubble train formation cannot explain the increase in thickness of horizon S_2 in the eastern part of the Melikhovskaya gas-bearing structure [5]. A normal marine cyclicity atypical of bubble train bodies can be distinctly seen in the cross sections of wells No 63, 90, 80 and others, not to mention the fact that core material has not supported classification of horizon S_2 as a bubble train in the indicated part of the Melikhovskaya fold.

The gas-bearing conditions of bubble train bodies examined here permit the conclusion that the results of exploratory drilling in zones of bubble train development in the southeastern part of the Dniepr-Donets depression require critical reexamination. Obviously the prospects for discovering significant accumulations of gas are associated with the largest salt stocks and swells, and primarily with unexplored zones of the Chutovsko-Belukhovskiy salt swell, and with the Yelizavetovsko-Tarasovskiy swell and the Seleshchinskiy salt stock, which have been subjected to hardly any drilling research.

In turn, mapping of bubble train bodies must be included among the objectives of the geophysical prospecting methods.

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OIL AND GAS

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CARBONATE GAS RESERVOIRS LOCATED IN DNIEPR-DONETS DEPRESSION

Kiev NEFTYANAYA I GAZOVAYA PROMYSHLENNOST' in Russian No 3, Jul-Sep 84 pp 3-6

[Article by O. F. Ryabykh and A. F. Priymenko, UkrNIIgaz: "Carbonate Reservoirs in a Permian Halogen Mass of the Dniepr-Donets Depression"]

[Text] Gas accumulations were established in the Svyatogorskaya member of the Nikitovskaya suite as well as in the Podbryantsevskaya, Bryantsevskaya and Nadbryantsevskaya members of the Slavyanskaya suite of a number of deposits of the Dniepr-Donets depression, in Permian halogen rock masses. Hydrocarbon accumulations have not yet been detected in the Kramatorskaya suite [1].

Dolomite, limestone, sandstone and aleurolite serve as gas reservoirs in the Nikitovskaya suite, while carbonate rock, salinized to varying degrees by halite, serves as the gas reservoir in the Slavyanskaya suite. This type of rock is encountered throughout the entire section of the Nikitovskaya and Slavyanskaya suites. Occurrence of sandstone cemented by halite is probable in the Kramatorskaya suite. The drilling experience in the Mashevskoye deposit indicates that when drilling mud interacts with filtrate, reservoirs of this sort break down in the well's bottom-hole zone [2].

Incontestable material on reservoir rock in the productive Podbryantsevskaya member of the Slavyanskaya suite was obtained from well No 33 drilled by the Shebelinskoye Drilling Operations Administration at the Melikhovskoye deposit. This well was drilled in accordance with recommendations of the UkrNIIgaz [Ukrainian Scientific-Research Gas Institute]; the core was continuously sampled in the productive part of the section. Well No 33 is located 600 m east of the Vostochno-Medvedovskiy Devonian salt stock. The thickness of the Mesocenozoic layer of its section is about 1,670 m, that of the Upper Permian Shebelinskaya suite is 295 m, and that of the Peresazhskaya suite is 51 m. The upper horizons of a Permian halogen rock mass--a Kramatorskaya suite and the Krasnosel'skaya member of a Slavyanskaya suite--are absent from the section. The Peresazhskaya suite underlies the Slavyanskaya suite's Nadbryantsevskaya member, which is 50 m thick, below which a Bryantsevskaya member 79 m thick can be distinguished. Between the Bryantsevskaya and Podbryantsevskaya members the halogen rock mass is invaded by salts of the cap of a Devonian stock; the salts are 221 m thick. The Podbryantsevskaya member of the Slavyanskaya suite is 146 m thick, while the Torskaya and Svyatogorskaya members of the Nikitovskaya suite are 158 and 197 m thick, respectively.

According to the results of core analysis (Figure 1), the Podbryantsevskaya member consists of salinized dolomite, layered seams of anhydrite and layered marl about 1 and 0.67 m thick respectively, within the 15-meter interval from the surface. In places, carbonate rock contains 1-1.5 cm halite inclusions; caverns caused by leaching out of halite can be seen on the surface of the core. Caverns not associated with drilling are encountered in cross sections of the core sampled from the upper of the three dolomite seams. Open cracks that cut vertically through the core are present in the lower seam. The porosity of dolomite rock in this member varies within 4.8-14.4 percent, permeability varies approximately from $0.01 \cdot 10^{-15}$ to $1.28 \cdot 10^{-15}$ m^2, and the porosity of marl exceeds 15.3 percent.

The Podbryantsevskaya member is underlain by anhydrite, by rock salt seams and by clay. Dolomite and marl formations are thin--from 0.05 to 0.5 m. The thickness of the halite-carbonate rock seam brought up in the core is greater than that of other variants of carbonate rock, being 1.75 m. According to the caliper log the thickness of this seam is 2.5 m. Two meters above it a similar constriction of the nominal diameter of the well can be distinguished in the 2,363.5-2,367 m interval, indicating presence of a porous seam 3.5 m thick. A core raised from a depth of 2,354-2,368 m brought up rock salt (0.45 m), anhydrite (6.95 m), dolomite marl (0.2 m), anhydrite (0.2 m), wave-bedded dolomite (0.2 m) and anhydrite (3 m). The open porosity of marl is 9.9 percent, permeability is $0.2 \cdot 10^{-15}$ m^2, and porosity of the dolomite is 1.5 percent. The possibility is not excluded that the upper minimum of the well diameter is situated opposite the dolomite marl seam.

Judging from the physical properties of rock brought up with the core, the gas reservoirs consist of dolomite, halite-carbonate rock and marl. The porosity of marl varies from 7.6 to 15.3 percent, and the permeability of the analyzed samples does not exceed $0.01 \cdot 10^{-15}$ m^2. Dolomite is typified by a porosity of 1.5-14.4 percent, while its permeability varies approximately from $0.01 \cdot 10^{-15}$ to $1.28 \cdot 10^{-15}$ m^2. The porosity of halite-carbonate rock is 4.8-28.6 percent, being maximum at the upper limit; permeability attains $3 \cdot 10^{-15}$ m^2. The high capacity of the seam of porous analogue of halite-carbonate rock lying in the upper part of the depth interval 2,368-2,381 m permits interpretation of this seam as productive in terms of gas content. The core sample from it contains condensate.

The Podbryantsevskaya member was tested twice by well No 33. The gas flow from the 2,310-2,395 m interval was found to be small--15,000 m^3/day. A second test which also probed underlying seams in the 2,310-2,450 m interval following hydrochloric acid treatment resulted in an absolutely free gas yield of 53,000 m^3/day at a reservoir pressure of 35.7 MPa. In the absence of a temperature log, it is difficult to determine which seam is producing in the testing interval. Porous analogues of halite-carbonate rock possess better indicators of physical properties in the tested interval, and therefore it would be natural to assume that following hydrochloric acid treatment, these are precisely the reservoirs which were responsible for the increase in flow.

Fourteen seams and interlayers of carbonate rock represented primarily by terrigenic, sulfate-carbonate and chloride-carbonate varieties of mixed

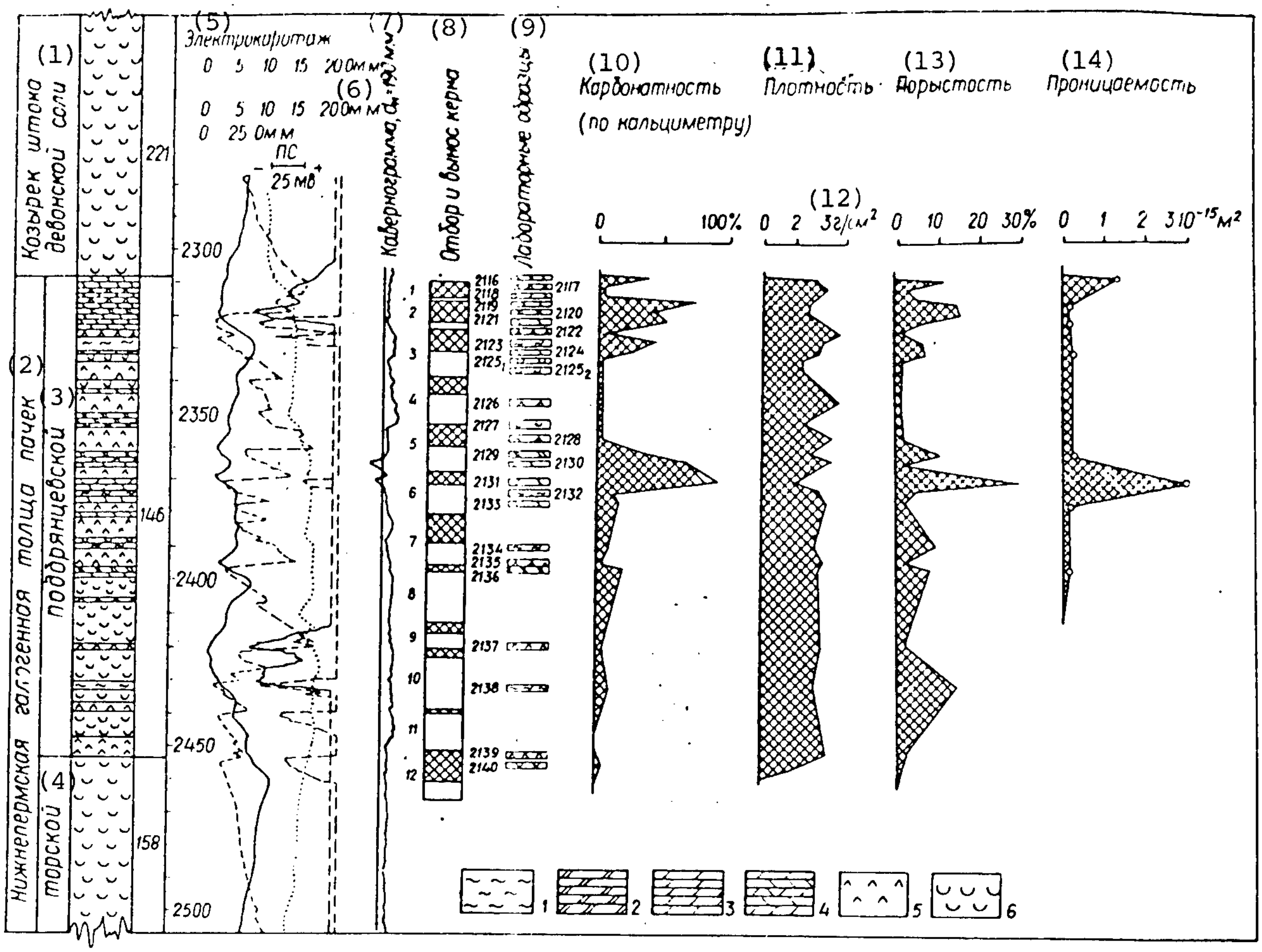

Figure 1. Lithological Section and Physical Properties of Rock from the Podbryantsevskaya Member of the Slavyanskaya Suite, Determined by Well No 33 of the Melikhovskoye Deposit: *1*--clay; *2*--dolomite marl; *3*--dolomite; *4*--halite-carbonate rock and its porous analogues; *5*--anhydrites; *6*--rock salt

Key:

1. Devonian salt stock overhang
2. Lower Permian halogen rock mass of:
3. Podbryantsevskaya member
4. Torskaya member
5. Electric logging
6. ohms·m
7. Caliper log
8. Core sampling and removal
9. Laboratory samples
10. Carbonate content (determined by a calcimeter)
11. Density
12. gm/cm^2
13. Porosity
14. Permeability

composition were established in the Podbryantsevskaya member by the core from well No 33. Mathematical treatment of the results of chemical analyses of these rock samples established the content of terrigenic material (1-42 percent), pyrite (0.2-1 percent), calcite (up to 3 percent), dolomite (10-86 percent),

magnesite (up to 46 percent), anhydrite (up to 50 percent) and halite (up to 12 percent). The analyzed samples are typified by a high concentration of magnesite in four seams and a modest concentration of potassium impurities in all samples.

The ubiquitous presence of potassium impurities is associated in this case with dissolution of part of the potassium-containing minerals in terrigenic impurities in the course of chemical analysis. The concentration of magnesite in one of the seams is significantly greater than that of dolomite, anhydrite and halite, being 46 percent; in the others it attains 30.3 and about 9 percent. The relatively low concentration of halite revealed in halite-carbonate rock is associated with the fact that porous analogues of this rock were analyzed.

Owing to leaching out of a significant quantity of halite, it is difficult to recognize porous analogues of halite-carbonate rock in the core. One of the indicative diagnostic signs is a brownish crust of drilling mud on its surface. Such rock brought up by the core from well No 33 from a depth of 2,368-2,381 meters is whitish gray in color, it boils weakly in HCl, in places it transforms into carbonate-anhydrite rock within the lower part of the seam, and microsections reveal a porphyroblastic, porous structure. The bulk of it consists of very fine-grained carbonate. Clusters of pelitomorphic carbonate devoid of any definite outlines are present within such carbonate mass. A small quantity of clayey material is associated with pelitomorphic carbonate. It also contains anhydrite impurities that may be observed in the form of isolated aggregates and individual elongated nodules with corroded margins. Complete absence of organic remains and almost complete absence of nodule fragments are typical; a single small quartz nodule was encountered in only one of the microsections.

The rock is highly porous. Pores are of irregular shape. Inasmuch as the microsections were prepared using water, it may be assumed that some of them were filled with halite. Xenomorphism is a typical feature of halite coprecipitated with carbonate. The pores do not communicate, and characteristically their shape corresponds completely to xenomorphic halite inclusions in rock, in which this readily soluble component had not been subjected to leaching out.

Calculations based on chemical analyses revealed that the concentration of terrigenic material in halite-carbonate rock varies within 1-32 percent, that other concentration limits are 10-86 percent for dolomite, 1-28 percent for anhydrite, 3-12 percent for halite and 0.2-0.9 percent for pyrite, and that the concentrations of calcite and magnesite attain 3 percent and 46 percent respectively. Considering secondary leaching out of halite owing to the open porosity which attains a third of the volume of such rock, the ratio of rock forming components should be different.

A core was also sampled from the Podbryantsevskaya member of the Melikhovskoye deposit by well No 79. Samples of gray and brown clay, in places containing 5-millimeter interlayers of columnar halite and light gray dolomite, gray and yellowish gray anhydrite, white and brown rock salt and inclusions of pelito-halite rock were brought up. Halite-carbonate rock and its porous analogue

are found in the core taken by well No 63 from the Bryantsevskaya member of the Slavyanskaya suite and the Torskaya member of the Nikitovskaya suite; the thicknesses of these members are 6.45 and 7.4 m respectively. Laboratory research showed that the lower part of a seam in the Bryantsevskaya member, which contains a large number of nodule fragments and has a lower halite concentration (Figure 2), is distinguished by the best reservoir properties.

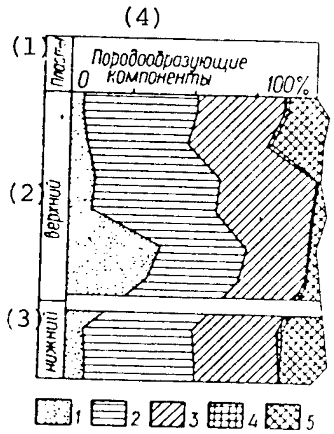

Figure 2. Mineral Composition of Halite-Carbonate Rock from a Permian Halogen Rock Mass of the Melikhovskoye Deposit: *1*--terrigenic material; *2*--$CaCO_3$; *3*--$MgCO_3$; *4*--anhydrites; *5*--halite

Key:

1. Seams
2. Upper
3. Lower
4. Rock forming components

It is evident from this description that salinization of different kinds of rock by halite is a typical feature of the productive Podbryantsevskaya member. Not only halite-carbonate rock with a 20-30 percent halite concentration but also other types of carbonate reservoirs can be salinized. The Podbryantsevskaya member is distinguished by high salt saturation. A core brought up from the Podbryantsevskaya member contained samples of salts from seven seams above a 75-meter salt seam enclosing a Torskaya member. According to the core the thickness of these seams varies from 0.3 to 2 m, which attests to the sedimentational nature of salinization of rock, including carbonate rock, interlayered with rock salt.

Carbonate rock revealed in the Melikhovskoye rise by wells No 63, 80, 90 and others, in which Svyatogorskaya, Torskaya and Podbryantsevskaya salts undergo transition from the arch of the structure to the Paraskoveyskiy stock [3], is water-encroached. The corresponding sediments in the Novoukrainskoye deposit are encroached to an even greater degree. Presence of reservoir water in the Permian halogen rock mass provides full grounds for suggesting that leaching of readily soluble halite out of the composition of halite-carbonate rock

was possible in the past and may be occurring now. Reservoirs containing accumulations of gas form in this way in a number of deposits of the Dniepr-Donets depression.

The research generally leads to the following conclusions:

1) the Slavyanskaya suite of the Permian halogen rock mass consists predominantly of halite-carbonate rock representing a sedimentary formation of an Early Permian halogen basin;

2) the latter is represented by polymineral rock which contains--besides calcium and magnesium carbonate and halite--terrigenic material, anhydrite and small quantities of iron sulfide; presence of readily soluble halite in this rock creates the possibility of its leaching out by ground water;

3) halite-carbonate rock was raised in a core from the Melikhovskoye deposit out of the Podbryantsevskaya and Bryantsevskaya members of the Slavyanskaya suite, as well as out of the Torskaya member of the Nikitovskaya suite; porous analogues of halite-carbonate rock with sufficiently high physical property indicators were revealed in the Podbryantsevskaya member; testing of the interval in which they occur produced commercial flows of gas.

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OIL AND GAS

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DETAILED RESERVOIR ANALYSIS IMPROVES GAS RESERVE PREDICTION

Kiev NEFTYANAYA I GAZOVAYA PROMYSHLENNOST' in Russian No 3, Jul-Sep 84 pp 6-9

[Article by R. N. Zasadnyy, V. M. Lakhnyuk and B. L. Krupskiy, UkrgiproNIIneft' (probably Ukrainian Scientific-Research Institute for the Design and Construction of Petroleum Industry Enterprises): "Verification of Reservoir Properties of Menilite Deposits"]

[Text] Errors in assessing the reservoir properties and oil and gas content of paleogenic deposits of the Precarpathian Inner Zone [1] are a result of the extreme lithological and structural irregularity of these deposits [2,4]. Consequently the first way to verify the criteria used to raise the reliability of the procedures of studying menilite reservoirs is acquisition of detailed information on the mineralogical characteristics of the rock forming material and cementing agent. The results of specific research conducted on samples of menilite rock from the Glubinnaya fold of the Bitkov-Babchenskoye deposit provide answers to the key questions associated with this problem. The lithological features of reservoirs and nonreservoirs were studied by a complex of methods including X-ray diffraction and electron microscopy with the participation of the Nadvornayaneftegaz Petroleum and Gas Extraction Administration.

According to granulometric analysis the concentration of coarse-grained components (0.5-0.25 and 1-0.5 mm) and the heavy component (0.1-0.01 mm) decreases consistently from sandstone (16.5, 10.2 and 0.5 percent) to aleurolite (1.8, 1.6 and 0.3 percent) and argillite (0.3, 0.25 and 0.15 percent), while the concentration of finer components (0.1-0.01, 0.01-0.005 and 0.005-0.001 mm) increases (correspondingly 24.5, 29.5 and 35 percent, 7.7, 15.5 and 43 percent, and 1.6, 4.5 and 15.7 percent). The concentration of the former in middle menilite rock is 1.2-2 times greater than in lower menilite rock, while the concentration of the latter is as many times lower. The dominant fractions are 0.25-0.1 mm (31-54 percent) in sandstone, 0.1-0.01 mm (26-35 percent) in aleurolite and 0.005-0.001 mm (44-54 percent) in argillite. The mean carbonate concentrations are 12.2 and 25.4 percent for samples of lower and middle menilite sandstone respectively (the extreme values are 31 and 45 percent), they are 13.7 and 20.1 percent for aleurolite, and 3.2 and 10 percent for argillite.

The principal rock forming mineral in sandstone-aleurolite rock is quartz (grain dimensions determined from microsections are within 0.04-0.2 mm). The intensity maximums on diffractograms indicate dominance of quartz grains in

all fractions (Figure 1). The rock forming minerals of argillite consist of mica-clay aggregates; the characteristic lines indicate presence of quartz, pyrite and feldspar as well. The latter is encountered in all lithlogical varieties, with its quantity being larger (5-10 percent) in argillite and in approximately the 0.1 mm fraction of sandstone-aleurolite formations. According to mineralogical analysis the quartz concentration attains 90-98 percent in lower menilite sandstone, 85-95 percent in aleurolite and 5-24 percent in argillite. The concentration of mica-clay and hydrous mica aggregates is not more than 5-10 percent in reservoirs and 75-85 percent in argillite.

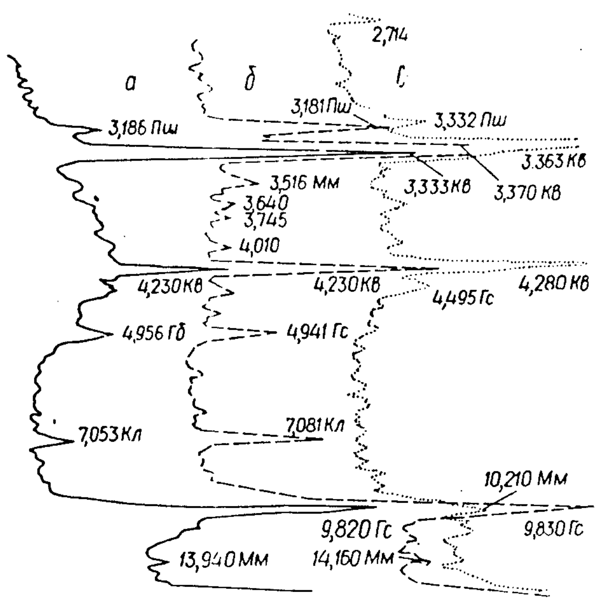

Figure 1. Diffractograms of the Pelitic Fraction of Clayey Aleurolite (a, b) and Sandstone (c) Showing the Interplanar Distances of Minerals (Кв--quartz, Кл--kaolinite, Пш--feldspar, Гс--hydrous mica, Мм--montmorillonite, Гб--hydrobiotite): a--well No 704, 2,977-2985 m interval, P_3Ml_1; b--well No 644, 2,911-2913 m interval, P_3Ml_2; c--well No 644, 3,098-3,104 m interval, P_3Ml_1

Presence of chalcedony in coarse aleurolite fractions, of glauconite in argillite (2 percent) and aleurolite (10-15 percent) and of marcasite, pyrite, chlorite, amphibole and granite in coarse argillite fractions (1-2 percent) are a typical feature of this rock; these minerals are absent or they are encountered in smaller quantities in middle menilite argillite. The 0.25-0.01 mm fraction of some samples of sandstone-aleurolite rock from the middle menilite subsuite contains 20-25 percent chalcedony in addition to quartz (60-90 percent) and mica-clay aggregates; in coarse fractions the chalcedony concentration is about 75 percent, while that of quartz is 20-30 percent. The

concentration of quartz is 10-15 percent lower in aleurolite than in sandstone, and in middle menilite varieties than in lower menilite sandstone. Heavy fractions of menilite rock are represented by marcasite and pyrite (5-95 percent), zircon (5-47 percent), granite (1-23 percent), tourmaline (1-16 percent), rutile (1-13 percent), ilmenite (1-3 percent), leucoxene (1-2 percent), anatase, staurolite, disthene, puroxene, amphibole, siderite, biotite, hydrogeothite, sillimanite, hematite and barite. The first eight minerals are correlative for the deposits under analysis. Tourmaline is encountered only in lithological varieties of the middle menilite subsuite, while hydrogoethite, sillimanite and hematite are encountered only in the pelitic fraction of argillite. Zircon, pyrite and marcasite concentrations are four to ten times greater in middle menilite sandstone then in lower menilite sandstone, while the concentrations of rutile, ilmenite and leucoxene are lower. As a rule, there is a larger concentration of correlative accessory minerals in sandstone than in aleurolite, while in argillite their concentration is lower than in sandstone and greater than in aleurolite.

The pelitic 0.01-0.001 mm fraction of sandstone-aleurolite rock has a polymineral composition: quartz, clay-mica aggregates, feldspar and traces of pyrite and other minerals were detected. The principal components are montmorillonite and hydrous mica of several morphological varieties. The mineralogical characteristics of clay-mica material vary with area and with depth. Usually the concentration of montmorillonite in sandstone increases with depth (beyond 2,900-3,000 m) while that of hydrous mica decreases. Variants of montmorillonite with diffuse outlines were encountered in most samples. Rock containing montmorillonite exhibits higher gamma-activity (abnormal values are observed only in relation to aleurolite and argillite when the concentration of glauconite and fledspar, which take up ^{40}K, is increased to 10 percent).

Heterogeneity of material composition results in a wide range of variation of the physical properties of the rock under investigation. Open porosity of sandstone-alleurolite varieties varies from fractions of a percent to 27.2 percent, permeability varies from 0.001 to several hundred millidarcies, fracture capacity varies from 0.1 to 0.8 percent, mineralogical density varies from 2.3 to 2.8 gm/cm^3, and volume density varies from 2.2 to 2.7 gm/cm^3. Highly porous quartz varieties ($K_{\Pi} > 10$-12 percent) dominate in sandstone from the lower menilite section, while middle menilite sandstone contains a significant quantity of carbonated varieties with a porosity below 10 percent. The open porosity of the overwhelming number of aleurolite seams containing a higher concentration of montmorillonite rarely exceeds 7-10 percent.

The total influence of heterogeneities in material composition of rock is reflected in the distribution polygons of physical properties, and it has an influence on the nature of their interaction. Irrespective of age, porosity distribution polygons are described by normal curves, the tails of which extend into the 15-27 percent range for lower menilite sandstone and the 15-20 percent range for middle menilite sandstone. The difference stems from the level of development of secondary processes and the degree of clogging of empty spaces

by clay-carbonate material of complex mineral composition. As the clay content of rock increases to 25 percent or as carbonate content increases to 5-6 percent, permeability decreases to 0.1 millidarcies while porosity decreases to 5 percent. A noticeable worsening occurs in permeability (sometimes by a factor of 1.5-2) and porosity in response to an increase in the concentration of montmorillonite in the pelitic fraction in relation to hydrous mica. Therefore the mutual correlation between permeability and porosity is very weak [2,5]. Change in the concentration of quartz, clay-mica minerals and carbonate matter has an effect on the volume (σ) and mineralogical (δ) density of the rock. Each lithological variety is described by a separate mutual correlation between porosity and volume density. The generalized dependence for the menilite section can be differentiated with respect to mineralogical density (2.3-2.65 gm/cm^3 for clay and argillite, 2.5-2.7 for aleurolite, 2.6-2.8 for quartz sandstone, 2.7-2.85 for carbonated sandstone and 2.75-2.9 gm/cm^3 for silicified sandstone):

$$K_n = 58.31 - 24.507\sigma + 3.94\delta.$$

Petrophysical features of menilite rock, as determined by this and previous studies, indicate that paleogenic reservoirs of the Precarpathian Inner Zone are represented primarily by weak-clay ($C_{гл}<10-15$ percent) and low-carbonate ($C<5$ percent) quartz sandstone;

there are more correlative materials (marcasite and pyrite, zircon and granite, tourmaline and rutile, ilmenite and leucoxene) in sandstone than in argillite and aleurolite; a decrease in the concentration of rutile, ilmenite and leukoxene in conjunction with a simultaneous increase in the concentration of zircon, pyrite and marcasite is characteristic of highly porous reservoir varieties (P_3Ml_1);

absence of abnormal inclusions of radioactive elements in sandstone and the higher concentration of aleurorite-argillite varieties in the latter create favorable conditions for using the gamma-method to isolate reservoirs and predict the capacity of rock using data acquired by neutron gamma-ray and gamma-ray methods;

the good density differentiation of the rock indicates a possibility for lithological subdivision of the menilite suite on the basis of a complex of data acquired by well radiometry and acoustic logging;

in order to raise the reliability of isolating reservoirs and evaluating their filtrational and capacity properties, we need to take account of the total influence of the heterogeneity of the seams on the use of nontraditional methods [6].

These conclusions were verified in the methodological and applied aspects:

It was established [2,5] that cases of greater or lesser effective seam thickness are, according to data acquired by geophysical methods, a result of the variability of conditional limits of capacity (7-15 percent) owing to mineralogical heterogeneity of the rock;

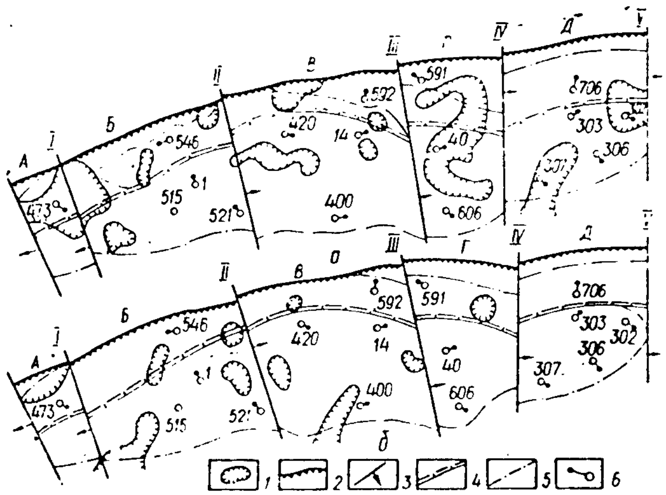

Figure 2. Diagrams Showing Locations of Zones of No Reservoirs, Determined from Oil Field Geophysical Data, in Deposits of the Middle Menilite (*a*) and Lower Menilite (*b*) Suites of the Glubinaya Fold: *1*--zone of no reservoirs; *2*--thrust line; *3*--tectonic deformations (*I*--Babchenksoye deformation, *II*--Bystritsko-Nadvornyanskoye deformation, *III*--Lyubizhnyanskoye deformation, *IV*--Delyatinskoye deformation, *V*--Prutskiy fault); *4*--longitudinal reversed fault; *5*--oil-gas contact; *6*--wells; А--Babchinskiy, Б--Bitkovskiy, В--Pasechnyanskiy, Г--Lyubizhnyanskiy and Д--Delyatinskiy blocks.

efficient methods of predicting menilite reservoirs [2] (including statistical methods [3]) and a single procedure for studying their capacity properties [5] on the basis of a complex of acoustic, radiometric and electrometric characteristics were developed;

the significant influence of the failure to account for the material composition of menilite deposits upon the parameters used to calculate hydrocarbon reserves was demonstrated [5].

The practical results of introducing these developments are consistent with data on the detailed material composition of the rock and its influence on the filtrational and capacity properties of reservoirs. In particular, large areas of no reservoirs were discovered (Figure 2), presence of which must be accounted for when calculating hydrocarbon reserves. Such areas are noticeably greater in number in deposits of the middle menilite suite (see Figure 2*a*), which can be explained by an increase in clogging of the empty spaces by limestone and highly dispersed clay (especially montmorillonite) material.

It follows from the experimental materials presented here and the results of studying menilite deposits using geophysical data that the objective of improving the methods of diagnosing reservoir properties can be achieved by determining the petrophysical basis in detail.

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OIL AND GAS

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GAS FORMATION, ACCUMULATION PREDICTED FOR DNIEPR-DONETS BASIN

Kiev NEFTYANAYA I GAZOVAYA PROMYSHLENNOST' in Russian No 3, Jul-Sep 84 pp 9-12

[Article by Yu. G. Lapchinskiy and S. P. Nesterenko, UkrNIIgaz (Ukrainian Scientific-Research Gas Institute): "Scales of Gas Formation and Gas Accumulation in the Dniepr-Donets Depression"]

[Text] The Dniepr-Donets depression (DDD), in which the deposits presently under development are associated with Carboniferous oil and gas bearing complexes, is the principal oil and gas region of the Ukraine. Predominant gas accumulation in the DDD is confined, especially in its eastern section, to the range of development of sub-Carboniferous deposits. To permit evaluation of the total resources, the volumes and densities of gas formation and gas accumulation were determined using the volumetric-genetic method, which makes it possible to establish the upper limits of these resources and which is a control in relation to the method of comparative geological anomalies. The Lower Carboniferous Serpukhovsko-Verkhnevizeyskaya series ($C_1^{V_2+S}$)--a formation containing commercially feasible coal reserves in the western Donets Basin--and the Middle Carboniferous Moskovskaya and Bashkirskaya series (C_2)--the principal coal bearing series of the Donets Basin *per se*--were selected as the objects of calculation. These calculations were carried out using a variant of a method developed by the All-Union Scientific Research Institute of Natural Gas intended for regions of development of coal bearing deposits [1]. This was the first time that the region's gas formation was evaluated with regard for total humic organic matter both in the form of dispersed organic matter which had been accounted for in previous calculations, and in concentrated form--seams, interlayers and lenses of coal and dispersed coal-like material (detritus).

Data on the composition and concentration of dispersed organic matter [2], on the detailed composition of organic matter, on the fascial-genetic type and on the stages of catagenesis of dispersed organic matter [3,4] were used in the calculations. Information on the occurrence of concentrated organic matter (thickness, metamorphism, ash content and so on) were obtained by interpretation of a modest amount of library materials from coal and oil-gas prospecting enterprises. The relationship between all forms of concentrated organic matter was adopted the same as for the Donets Basin [5]. Values of gas production in different stages of catagenesis of humic and mixed sapropelic-humic organic matter were employed [6].

Seventeen oil and gas collecting sectors that are confined in terms of migration, determined by researchers of the Ukrainian Scientific Research Institute of Geological Exploration, were adopted as the basis for the calculations. In this case we combined the the extreme southeastern sectors--Spivakovsko-Krasnooskol'skiy (XV), Petrovsko-Druzhkovskiy (XVI) and Slavyanskiy (XVII)--into the single sector XV, which was also included in the territory of the Bakhmutskaya and Kal'mius-Toretskaya basins. Moreover the northern margins of the Donets Basin were separated out additionally as sector XVI (Table 1).

The fact that the total thickness of organic matter in the DDD varies within wide limits--for example, from 4.3 m (sector XVI) to 50 m (sector XV) in Lower Carboniferous formations of the southeastern part, and from 13 m (sector XII) to 88 m (sector XV) in Middle Carboniferous formations--has important significance to gas generation. On the average the total thickness of organic matter in the northwestern part was three times smaller than in the southeastern part. Were we to look at the structure of the organic matter, we would find that dispersed organic matter dominates in the Lower Carboniferous formation: The ratio of concentrated to dispersed organic matter for the entire DDD is 0.9, while in the southeast it varies from 0.5 (sector XIII) to 2.5 (sector XIV); on the other hand in the Middle Carboniferous formation the conditions favored accumulation of concentrated forms: The ratio of concentrated to dispersed organic matter is 2.2 for the DDD, and from 0.6 (sector XII) to 2.8 (sector XIV) for the southeast. The stages of catagenesis of organic matter in both carboniferous formations vary from PK(BD) to MK_3(Zh) in the northwest and from MK_1(D) to AK(T-PA) in the southeast.

The results of determining the volumes and densities of generation of gaseous hydrocarbons permitted the following basic conclusions:

The volumes and densities of gas generation in the Lower Carboniferous complex ($C_1^{V,+S}$) exceeds generation in the Middle Carboniferous formation insignificantly (by 6.6 percent);

generation of gases in the eastern part of the DDD exceeds that in the western part of the depression by a factor of nine in terms of scale and a factor of eight in terms of density;

the maximum total densities of gas formation are associated with the southeast of the DDD, including with its axial part (sector XV--200-400 percent, and sectors XII-XIII--80-200 percent), as well as with the southern marginal zone (sector XIV--80-200 percent);

more than half the gas of the entire DDD (53 percent) was generated in sector XV. Generation density in this area twice exceeds the average density for the southeastern part of the depression, and it is almost four times the average density for the entire DDD;

the scales of gas formation calculated for the Bakhmutskaya and Kal'nius-Toretskaya basins are 31 percent of total gas formation in the DDD and 59 percent of total gas formation in sector XV;

Table 1. Indicators Characterizing Generation of Gaseous Hydrocarbons in Relation to the Principal Carboniferous Oil and Gas Bearing Complexes of the DDD, percent

(1) Подсчетный сектор		$C_1^{V_3+S}$	C_2	$C_1^{V_3+S}+C_2$
(2) Номер	(3) Наименование			
	(4) Западная часть			
I	Ведильцевско-Холмский (5)	0,6/5,4	0,7/5,4	1,3/10,8
II	Краснопартизанско-Ичнянский (6)	0,2/10,8	0,4/16,2	0,6/27,0
III	Носовско-Монастырищенский (7)	0,2/10,8	0,1/5,4	0,3/16,2
IV	Великозагоровско-Синевский (8)	0,6/10,8	0,6/10,8	1,2/21,6
V	Station Леляковско-Чернухинский (9)	0,3/8,1	0,7/16,2	1,0/24,3
VI	Гнилицко-Рейзеровский (10)	0,2/10,8	0,1/8,1	0,3/18,9
VII	Глинско-Розбышевский (11)	0,6/24,3	0,3/10,8	0,9/35,1
VIII	Синевско-Валковский (12)	0,9/10,8	0,8/10,8	1,7/21,6
IX	Солоховско-Диканьский (13)	0,5/21,6	0,5/18,9	1,0/40,5
X	Исачковско-Зачепиловский (14)	0,7/8,1	0,5/5,4	1,2/13,5
	Итого (15)	4,8/10,8	4,7/10,8	9,5/21,6
	(16) Восточная часть			
XI	Валковско-Купянский (17)	3,8/21,6	6,0/32,4	9,8/54,0
XII	Распашновско-Шебелинский (18)	4,0/100,0	3,0/75,7	7,0/175,7
XIII	Тарасовско-Беляевский (19)	1,1/43,2	1,9/73,0	3,0/116,2
XIV	Суходоловско-Мечебиловский (20)	9,4/78,4	5,4/45,9	14,8/124,3
XIVa	Полтавско-Машевский (21)	0,4/37,8	0,2/24,3	0,6/62,1
XV	Спиваковско-Дружелюбовский (22)	27,9/205,4	26,2/191,9	54,1/397,3
XVI	Северные окраины Донбасса (23)	0,2/10,8	1,0/45,9	1,2/56,7
	Итого (15)	46,8/86,5	43,7/81,1	90,5/167,6
	ДДВ в целом (24)	51,6/51,4	48,4/48,6	100,0/100,0

Key:
1. Calculation sector
2. Number
3. Name
4. Western part
5. Vedil'tsevsko-Kholmskiy
6. Krasnopartizansko-Ichnyanskiy
7. Nosovsko-Monastyrishchenskiy
8. Velikozagorovsko-Sinevskiy
9. Lelyakovsko-Chernukhinskiy
10. Gnilitsko-Reyzerovskiy
11. Glinsko-Rozbyshevskiy
12. Sinevsko-Valkovskiy
13. Solokhovsko-Dikan'skiy
14. Isachkovsko-Zachepilovskiy
15. Total
16. Eastern part
17. Valkovsko-Kupyanskiy
18. Raspashnovsko-Shebelinskiy
19. Tarasovsko-Belyayevskiy
20. Sukhodolovsko-Mechbilovskiy
21. Poltavsko-Mashevskiy
22. Spivakovsko-Druzhelyubovskiy
23. Northern margins of Donets Basin
24. DDD as a whole

Note: Volumetric data are given in the numerator, density data are given in the denominator.

The ratio of the densities of total generation of gaseous hydrocarbons, calculated by us, to the densities of liquid hydrocarbon generation determined from dispersed organic matter [7] shows that the more-universal gas formation process dominates both in the DDD in general--up to 4:1--and in its individual parts, particularly in the southeast--over 7:1.

Gas accumulation volumes were determined with the help of accumulation coefficients (K_a) obtained by B. P. Kabyshev for each sector separately as a result of comparing the initial total gas resources accounted for by the method of geological analogies with the volumes of gas generation by dispersed organic matter. K_a averages 0.01 for formation C_2 in the DDD and 0.028 for the $C_1^{V_1+S}$ complex. The results of control determination of K_a for the five most extensively explored sectors (III, V, VII, VIII and IX), performed by us with regard for gas generation both by dispersed and by concentrated organic matter, practically coincided with the figures given above: 0.08 for C_2 and 0.022 for C_1. Average K_a values for the western and eastern parts of the DDD were used for C_2 in sectors I, II, III and for C_2 and $C_1^{V_1+S}$ for sectors XV and XVI.

Table 2. Predicted Indicators of Accumulation of Gaseous Hydrocarbons by the Principal Carboniferous Oil and Gas Bearing Complexes of the DDD

(1) Подсчетный сектор	$C_1^{V_1+S}$			C_2			$C_1^{V_1+S}+C_2$	
	K_a	(2) Объем	(3) Плотность	K_a	(2) Объем	(3) Плотность	(2) Объем	(3) Плотность
Западная часть (4)								
I	0,005	0,1	1,3	0,018	0,6	5,3	0,7	6,6
II	0,014	0,1	6,8	0,018	0,3	14,1	0,4	20,9
III	0,007	0,1	3,7	0,018	0,1	4,9	0,2	8,6
IV	0,152	4,6	73,3	0,032	1,0	16,3	5,6	89,6
V	0,102	1,7	42,0	0,019	0,6	15,5	2,3	57,5
VI	0,033	0,3	16,3	0,018	0,1	6,8	0,4	23,1
VII	0,057	1,8	66,8	0,081	1,3	48,3	3,1	115.1
VIII	0,114	4,3	59,6	0,032	1,3	17,9	5,6	77,5
IX	0,047	1,2	49,1	0,016	0,4	15,3	1,6	64,4
X	0,101	3,4	46,9	0,014	0,3	3,9	3,7	50,8
Итого (5)	0,083	17,6	37,2	0,018	6,0	12,8	23,6	50,0
Восточная часть (6)								
XI	0,047	8,8	49,6	0,017	5,0	28,1	13,8	77,7
XII	0,026	5,1	128,3	0,013	1,9	48,0	7,0	176,3
XIII	0,017	0,9	36,3	0,026	2,3	92,4	3,2	128,7
XIV	0,021	9,6	82,5	0,031	8,2	70,1	17,8	152,6
XIVa	0,019	0,4	34,9	0,031	0,4	37,9	0,8	72,8
XV	0,016	21,8	162,3	0,009	11,4	85,6	33,22	47,9
XVI	0,016	0,2	8,3	0,009	0,4	21,1	0,6	29,4
Итого (5)	0,016	46,8	88,8	0,009	29,6	56,5	76,4	145,3
ДДВ в целом (7)	0,028	64,4	64,3	0,010	35,6	35,7	100,0	100,0

Key:

1. Calculation sector
2. Volume
3. Density
4. Western part
5. Subtotal
6. Eastern part
7. Total for DDD

It follows from Table 2, which gives the predicted volumes and densities of accumulation of free gas, that:

the volume of gas accumulation in the Lower Carboniferous formation is greater than in the Middle Carboniferous by a factor of 1.8 (2.9 in the western part of the DDD and 1.6 in the eastern part), which is partially the result of vertical migration of gases out of the Middle Carboniferous formation;

the volume of gas accumulation in the eastern part of the DDD is 3.2 times greater than in the western part (2.6 times greater in $C_1^{V,+S}$ and 4.9 times greater in C_2);

in the western part of the depression, the northern marginal zone (sector IV together with the Talalayevskoye and other deposits and sector VIII together with deposits of the Kachanovsko-Novotroitskaya and Kotelevsko-Berezovskaya groups) and the central zone (sector VII together with the Pogarshchinskoye and other deposits) are distinguished by a greater density of total accumulation;

in the eastern part of the depression, the maximum densities of total accumulation are associated with the central zone (sector XII and the Shebelinskoye and Zapadnokrestishchenskoye deposits) and the southern marginal zone (sector XIV);

the gas accumulation volume in $C_1^{V,+S}$ and C_2 in sector XV is 33 percent of accumulation in the DDD as a whole. The predicted volume of gas accumulation in the Bakhmutskaya and Kal'mius-Toretskaya basins is 19 percent of total gas accumulation in the DDD and 58 percent of gas accumulation in sector XV;

relatively higher densities of total accumulation of liquid hydrocarbons are associated with the northern marginal zone of the depression (sectors IV, VIII and XI and the Kachanovskoye, Novotroitskoye and other deposits).

The volumes and densities of free gas accumulation calculated by us are compared with the initial total resources determined by B. P. Kabyshev et al. (1980) using the geological analogies method in Table 3. On the average for both Carboniferous oil and gas bearing complexes of the DDD, the values calculated by the former method turned out to be 2.8 times greater than the values calculated by the latter method (by 5.4 times for C_2 and by 2.5 times for $C_1^{V,+S}$); this includes 1.5 times greater for the western part of the DDD and 4.2 times greater for the eastern part. The gas accumulation indicators obtained by the volumetric-genetic method are obviously the maximum possible values for the examined oil and gas bearing complexes. The incompleteness of information on the concentration of concentrated organic matter in the Carboniferous formation of the DDD as well as disregard of the volumes of gas formation in the Nizhnevizeysko-Turneyskiy complex and, in the southeast, the upper structures of the Upper Carboniferous and Lower Permian complexes are responsible for understatement of these indicators somewhat.

Gas formation and gas accumulation processes are separated in time in the DDD. While according to the volumetric-genetic method the principal volumes of gas

Table 3. Comparison of the Indicators of Accumulation of Gaseous Hydrocarbons in the Principal Carboniferous Oil and Gas Bearing Complexes of the DDD, percent

$C_1^{V_2}+S$		C_2		$C_1^{V_2}+S+C_2$	
(1) Объем	(2) Плотность	(1) Объем	(2) Плотность	(1) Объем	(2) Плотность
Западная часть (3)					
42,6 / 52,1	88,5 / 107,7	3,6 / 17,7	7,7 / 38,5	46,2 / 69,8	96,2 / 146,2
Восточная часть (4)					
38,1 / 136,8	73,1 / 253,8	15,7 / 87,0	30,8 / 161,5	53,8 / 223,8	103,9 / 415,3
ДДВ в целом (5)					
80,7 / 188,9	80,8 / 184,6	19,3 / 104,7	19,2 / 103,8	100,0 / 293,6	100,0 / 288,4

Notes: 1. Data determined by the method of geological analogy are in the numerator, and data obtained by the volumetric-genetic method are in the denominator.
2. Volume data determined by the method of geological analogies were established without regard for sector XVI.

Key:
1. Volume
2. Density
3. Western part
4. Eastern part
5. DDD as a whole

accumulation directly proportional to generation volumes are associated with the Lower Carboniferous (70 percent) and Middle Carboniferous (25 percent) complexes, about 50 percent are associated with the Upper Carboniferous-Lower Permian complex according to the method of geological anomalies, and 70 percent are associated with the former according to the structure of revealed reserves. This is a direct consequence of vertical migration of gas from the Lower and Middle Carboniferous formation beneath the regional Lower Permian salt mantle.

The results of the research suggest that significant reserves exist for discovering new gas and gas-condensate accumulations in the DDD. Regions located in the southeastern part of the DDD--sector XV, as well as sectors XII, XIII and XIV--are the most promising in terms of the geological and geochemical conditions of their formation.

It must be considered that in sector XV and especially in the Bakhmutskaya and Kal'mius-Toretskaya basins gas accumulation obviously occurred both in the course of lateral movements of gas within Lower and Middle Carboniferous accumulations in the K-T stages of catagenesis, where given the presence of abnormally high reservoir pressures, mixed and fractured reservoirs are possible, and in response to disintegration of these accumulations owing to

vertical migration of gas in massive Upper Carboniferous-Lower Permian accumulations, where pore reservoirs are developed to stages D-Zh of catagenesis. Therefore the scales and densities of gas accumulation in sector XV (see Table 2) should be interpreted as a quantitative expression of the activity of a powerful center of predominant gas generation, though gas accumulation is actually associated with a wider stratigraphic interval.

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11004
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OIL AND GAS

UDC 553.981.551.734.3(477.82)

LOKACHINSKOYE GAS DEPOSIT DESCRIBED

Kiev NEFTYANAYA I GAZOVAYA PROMYSHLENNOST' in Russian No 3, Jul-Sep 84 pp 16-17

[Article by V. M. Rudnichenko, V. M. Markovskiy and A. N. Ishchenko, Zapukrgeologiya TP PGO and the Lvov KNIO of UkrNIIgas (Ukrainian Scientific-Research Gas Institute): "Features of Devonian Gas Accumulations of the Lokachinskoye Deposit"]

[Text] The principal phase of research on the Lokachinskoye gas deposit, the first industrial accumulation of liquid hydrocarbons within the vast territory covered by the Volyno-Podol'sk margin of the East European platform, was completed in 1982.

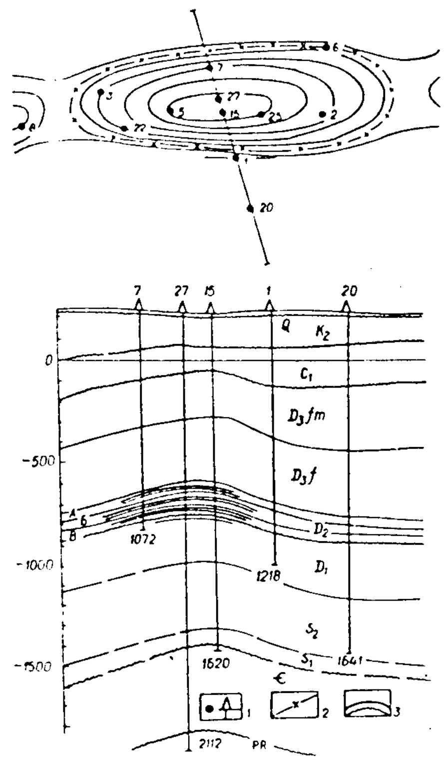
Facts were obtained making it possible to provide a sufficiently complete description of the structural forms of traps, the lithological-petrographical and reservoir properties of productive deposits and the peculiarities of the gas accumulations, and to offer recommendations on the directions of study of new deposits in the region.

Sediments encompassing the middle section and the bottom of the top section of the Devonian system, located at a depth of 810-1,060 m, are gas bearing in the Lokachinskoye deposit. This unique rock mass, which is very distinctly seen in the Devonian section over a large part of the Lvov depression, and the initial formation stages of which are associated with its accumulation, is a succession of variable-thickness sulfate-dolomite and clay fragment members, with the former clearly dominating. These deposits occur on the eroded surface of a Lower Devonian aleurolite-sandstone sedimentary complex, the weathering core of which also contains small gas accumulations. A thick monotonous mass of secondary dolomite and dolomitized organogenic limestone of the Franskiy and Famenskiy stages is located concordantly above.

Gas seepages confined to fracture-associated folded deformations at depths of 2,200-2,300 m occurred out of Middle and Lower Devonian deposits in the central part of the Lvov depression, in the Velikomostovskaya area.

The Lokachinskoye gas deposit is located on the northeastern periphery of the Lvov depression, within the limits of a dislocation line called the Lokachinskiy swell, with its axis extended about 40 km from southwest to northeast. A local uplift that is of extended oval shape in plan view--the Lokachinskaya fold *per se*--is distinctly set apart on the Lokachinskiy swell owing to

flexure of a hinge fault. According to all key beds in the productive series, the fold is an asymmetrical anticline oriented toward the northeast with a short and steep (5-7°) southeastern wing and an extended and gently sloping (not more than 3°) northwestern wing. The fold's periclines are gently sloping. The fold's length along the 680 m isogone varies within 9-10 km, and its width is 3.5-4 km. The amplitude of the uplift attains 100 m, and its arch is located practically in the center of a closed contour (see Figure).



Structural map of the deposit based on one of its productive horizons, and a schematic geological section of the deposit: *1*--wells; *2*--gas-water contact; *3*--gas accumulations; A--Strutinskaya, Б--Pelchinskaya and B--Lopushanskaya suites

The Middle Devonian section with which the principal gas accumulations are associated is distinguished by clear dominance of clayey rock represented by finely elutriated scaly argillite and argillite-like clay enriched by highly modified tufa material. The second lithological component of the productive series in terms of concentration is chemogenic rock--a paragenetic complex of sedimentary dolomite and anhydrite existing in a complex and varying relationship. Anhydrites tend to be located in the lower and upper portions of this section, where they form both rather thick isolated seams (up to 8 m) and thin frequent interlayers in clay and dolomite members. Intensive sulfation of sedimentary dolomite is extremely typical.

The reservoirs are represented by fragmented rock forming vertically separated intercalations predominantly in a clay section. This rock consists of coarse-grained aleurolite and fine-grained sandstone of oligomictic quartz composition, interspersed with one another in the productive seams. Their relationship noticeably varies in area--the reason for change in reservoir properties.

The capacity parameters of the reservoirs are determined by intergranular porosity of primary weakly cemented sandstone. Aleurolite and, all the more so, clay impurities reduce porosity. Widely encountered basal cementation by dolomite or sulfate material also affects capacity characteristics.

The mean values for open porosity of granular reservoirs vary within 3 and 19.8 percent, while permeability values determined in the laboratory vary from $0.01 \cdot 10^{-15}$ to $355 \cdot 10^{-15}$ μ^2.

Aleurolite-sandstone formations are a sharply subordinated component of the dolomite-sulfate-clay series. Six members from 1-1.5 to 5-6 m thick dominated by alternating aleurolite and sandstone are distinguished in the section of this series within the limits of the deposit.

Besudes granular reservoirs, the Middle Devonian section also contains cavernous fractured carbonate reservoirs represented by isolated thin (up to 2 m) seams of dolomitized limestone. However, in all probability they do not play a large role in the deposit.

The principal components of the clayey rock section are aggregates of hydrated and dehydrated hydrous mica containing minor impurities taking the form of mixed layers of hydrous mica-montmorillonite formations. They have excellent shielding properties.

While the Middle Devonian productive complex is relatively thin (130-150 m), six gas accumulations have been revealed in the deposit, in which the gas-water contacts are detected at absolute marks from -683 to -788 m, and the initial reservoir pressures of which are 8.5-9.8 MPa respectively.

Gas accumulations in the Middle Devonian section are contained in arched beds. The fascial newness of the intercalations and members of fragmented rock does not exclude the presence of lithological shields around some of them. The existence of lithological shields in the Srednestrutinskaya subsuite, in the uppermost deposit of the productive section, was established in the course of prospecting. The dimensions of the Middle Devonian accumulations are insignificant, varying from 7×2.2 to 10.2×3.2 km.

One arched accumulation of small dimensions (5.9×1.7 km) is confined to the weathering crust of Lower Devonian red sandstone. The gas-water contact is detected within at an absolute mark of -764 m, and the initial reservoir pressure is 9.6 MPa.

Gas within the deposit has a hydrocarbon composition. Its dominant component is methane (89-97 percent by volume). The gas contains an insignificant

quantity of condensate (1-2 cm^3/cm^3), the nitrogen concentration varies from 2.2 to 8.8 percent, while the carbon dioxide concentration varies from 0.05 to 1.8 percent.

Presence of sulfur compounds, primarily in the form of hydrogen sulfide and mercaptans, is a typical feature of the gas. The quantity of sulfuric impurities varies in relation to both productive horizons and area from 0.2 to 1.6 gm/m^3. Such significant fluctuations in sulfuric components of the gas is added evidence of the absence of a dynamic relationship between gas accumulations in individual productive horizons.

The revealed features of accumulations in the Lokachinskoye deposit may be taken into account during explorations conducted in promising areas of the Volyno-Podol'skaya margin of the Vostochno-Yevropeyskaya platform. Thus in particular, when productive horizons are exposed by drilling and gas inflow is induced, it should be kept in mind that the initial reservoir pressure in the accumulations is somewhat below hydrostatic (the shortfall is 0.2-0.6 MPa) and therefore their development would be an independent major task. Considering the presence of several isolated gas accumulations in the Devonian section, the productive section of new deposits should be tested within the smallest interval possible. At the same time the experience of planning development of the Lokachinskoye deposit shows that it would be sensible to test the entire productive Devonian section within a single interval using individual wells. This would make it possible to reveal numerous small productive intercalations which are usually not developed independently. Special attention should be devoted to clarifying the role of nongranular reservoirs in development of productive deposits. The concentration of hydrogen sulfide in the gas inflow must be carefully determined so as to insure the safety of prospecting operations and sensible development of the deposit in the future.

In order to protect the environment and the subsoil during drilling of accumulations of combustible gas containing hydrogen sulfide, abandonment jobs must be carried out with special care, especially in wells located within the gas bearing outline or near it.

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OIL AND GAS

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PROCEDURE SUGGESTED FOR DRILLING THROUGH FLUID ROCK

Kiev NEFTYANAYA I GAZOVAYA PROMYSHLENNOST' in Russian No 3, Jul-Sep 84 pp 20-22

[Article by V. N. Filev and Ye. F. Zubkov, UkrNIIgaz (Ukrainian Scientific-Research Gas Institute): "Prevention of Complications Associated With Fluidity of Rock"]

[Text] Fluidity of rock occupies a special place among the factors that complicate well drilling in the Ukraine, and in the Dniepr-Donets depression. Three manifestations of rock fluidity are the most characteristic of the Dniepr-Donets depression: flow of salt-containing rock at high temperatures and pressures; flow of potassium-magnesium salts and oozing of rock in the course of prolonged well operation.

A classical example of flow of salt-containing rock at high temperatures and pressures was well 500-Shebelinskaya. Drilling was rather successful to a depth of 5,142 m, when it was suddenly complicated by tenacious freezing, requiring redrilling of the shaft several times in the 5,100-5,181 m interval. Initially the drilling was conducted with BSK mud (clayless, salt-resistant with stabilizing properties) having a density of 1,170-1,200 kg/m^3, and then, to reduce rock cavings, ferrochromelignosulfonate mud with a higher density (1,400 kg/m^3) was employed. However, freezing began to occur at a greater frequency, and it was only after replacement of aqueous mud by bitumen-lime drilling mud that it was established that tapping of rock salt at a depth of 5,137 m was the true cause of all freezing, including with the use of bitumen-lime drilling mud with a density of 1,700 kg/m^3.

Having analyzed the strength properties of core salt from well 500 at the Groznyy Petroleum Scientific Research Institute and utilizing a procedure developed by the Poltava Department of the UkrNIGRI [Ukrainian Scientific Research Institute of Geological Exploration], we calculated the density of the drilling mud to be used in deepening the well. It was found to be equal to 2,350-2,400 kg/m^3 for static conditions and 2,180-2,200 kg/m^3 for dynamic conditions. The mud was weighted (in steps) to 2,200-2,300 kg/m^3. Narrowing of the shaft decreased significantly, though it did not stop completely. The well was deepened through the salt to the 5,394 m level, but then drilling was halted in view of the impossibility of raising the density of the drilling mud further (2,360-2,400 kg/m^3 and more) and maintaining the operating parameters of the bitumen-lime drilling mud at such a density.

More-successful engineering concepts for reducing complications in salt-containing rock were developed and utilized during the drilling of ultradeep well 100 in the Zapadno-Krestishchenskoye gas-condensate deposit, in which a stock of rock salt was drilled into at a depth of 1,522 m, which was in keeping with the projected section. The salt deposits should have ended at a depth of 4,850 m, while in fact the well did not get beyond them at its deepest point (6,606 m).

The plan foresaw drilling through the salt rock using mineralized clay mud of medium density, 1,280 kg/m^3, one at which fluidity of rock was not noted in neighboring wells that had been drilled earlier. However, starting at a depth of 3,200 m the drill string began to jam when it was lowered and experience drag when it was raised, the shaft required reaming, and freezing occurred. It was established that flow of salt rock owing to a deficit of hydrostatic pressure was the cause of the complications. Therefore in order to determine the drilling mud density necessary for deepening well 100 further, we used the procedures developed by the Poltava Department of the UkrNIGRI and the VolgogradNIPIneft' [possibly Volgograd Scientific-Research and Design Institute for Petroleum Industry Facilities] and the results of experiments in stepped grading of density.

The difference between shaft wall counterpressure values depending on drilling mud density, determined by the procedures indicated above, is highly significant. The well was drilled with mud of gradually increasing density, from 1,600 kg/m^3 at a depth of 4,200 m to 2,050 kg/m^3 at a depth of 6,606 m, which were found to be the closest to the density values calculated using the formula proposed by VolgogradNIPIneft'.

It should be noted that the mechanism behind transmission of pressure from viscous-plastic rock to the walls of a well shaft has not been studied adequately. We need to deepen research on this problem and hasten development of a single procedure for determining drilling mud density when drilling through salt-containing rock.

Flow of potassium-magnesium salts is most typical of the Mashevskaya and Vostochno-Poltavskaya areas.

Owing to the high solubility and fluidity of potassium-magnesium salts, serious complications arise in the course of drilling, stabilizing and assimilating (exploiting) wells--flow of rock into the shaft or the latter's erosion and the associated drag and breaking of drill pipes, and deformation of casings.

An analysis of oil field data permitted us to establish the following:

Piping experiences drag in the course of drilling when the rate of flow of potassium-magnesium salts (bischofite) exceeds the rate of their washing out (dissolution) by water-based mud;

breaking of the drill string occurs, on the other hand, when the rate of dissolution (washing-out) of bischofite exceeds the flow rate;

the integrity of casings is disturbed in wells in which the bischofite interval is washed out; presence, in a well section, of a large, as a rule asymmetrical cavern which is only partially filled during cementing, creates more-favorable conditions for bending of the string by flowing rock;

use of thick-walled piping when aqueous drilling muds are employed does not always guarantee that deformation would not occur, inasmuch as in the presence of high rock pressure and large caverns, the string breaks up as a result of flexing induced by lateral rock pressure;

flow of salts may be halted and formation of caverns may be averted using hydrocarbon-based muds with density corresponding to the rock pressure gradient.

For various reasons, and primarily in consideration of environmental protection, drilling with hydrocarbon-based muds is undesirable. Therefore to prevent deformation of the casings in the Mashevskaya area, a complex procedure foreseeing creation and maintenance of an "equilibrium" state in the well, in which flow of bischofite and its dissolution is balanced in time, and thus the shaft diameter remains at its nominal value, was proposed for well sections containing potassium-magnesium salts.

Two parameters--mud density and its magnesium ion concentration--are used as the basis for achieving this goal. When the density is assumed to be constant, the concentration of magnesium in the drilling mud must be adjusted within a wide range. When density is relatively low (in comparison with the geostatic pressure gradient), the concentration of magnesium in the drilling mud must be minimal, and a maximum washing-out time must be provided for. An increase in drilling mud density arrests fluid salts, as a result of which the concentration of magnesium in the drilling mud may be rather high owing to natural dissolution of bischofites in drilling mud having a lower mineralization limit.

By experimentally regulating both parameters--the density and concentration of magnesium in drilling mud that is salt-saturated in relation to NaCl, we can achieve a situation where the diameter of the well shaft would remain close to nominal within the section of fluid rock (salts) over a period of time long enough to permit lowering of the string, and thus the probability of creating high flexing moments would be minimized.

Use of this procedure when drilling wells 50, 50, 82 and 209 made it possible to finish their drilling and testing successfully and to confirm that even when highly fluid potassium-magnesium salts (bischofite) are present in a section, the well can be drilled using a water-based drilling mud.

Oozing of rock, which manifests itself in the course of prolonged operation of wells, is also associated with salt-containing rock in a chemogenic rock mass--in the Shebelinskoye, Yefremovskoye and other deposits. Deformation of the piping of production casings and upset tubing was recently discovered at these deposits. Multifaceted research and analysis of the deformations helped to reveal certain relationships and laws making it possible to reexamine the equipment and procedures of stabilizing salt-containing rock.

The intensity of salt flow and the time of its manifestation depend on many factors, among which the chemical composition and temperature of the environment, differential pressure and the composition of the drilling mud should be considered paramount.

Rock pressure upon the walls of a well shaft (and upon the well equipment contained within it) manifests itself most actively in Devonian salt stocks and overhangs. When salts are confined to seams in the chemogenic section and when wells are located far from salt stocks, manifestation of rock pressure through plastic rock (salts, salinized clay and so on) is absent as a rule in the course of drilling through the section as well as during operation of the well. Later on, in response to corrosion processes which are most active in the case of poor hardening of casings in salt-bearing deposits, and owing to erosive wear of casings during gas blow-through and withdrawal through the casing string-borehole annulus, the strength of the casing string decreases. Moreover as gas is withdrawn, internal pressure in the casings decreases, and thus the resistance of the casings drops to values at which their crushing by the external pressure of rock becomes possible.

Thus long-term trouble-free well operation requires a significant increase in the strength of casings isolating chemogenic deposits. One of the ways of doing this might be to additionally isolate the chemogenic section with an intermediate casing. Moreover the strength of casings isolating chemogenic deposits containing Devonian (overhang or stock) salt should be calculated with regard for rock pressure.

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OIL AND GAS

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INTEGRATED TREATMENT FACILITIES SERVICE SEVERAL GAS DEPOSITS

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[Article by V. V. Kaptsova and S. Ya. Bogdanovich, UkrNIIgaz (Ukrainian Scientific-Research Gas Institute): "Integrated Outfitting of a Group of Deposits"]

[Text] When gas is treated at gas-condensate deposits, it is important not only to obtain good quality gas but also to completely extract gas condensate--a valuable raw material for petrochemical industry--under the given thermobaric conditions. Progressive gas treatment procedures make this objective possible. Good quality treatment of the products of gas-condensate wells at the gas field provides a possibility for extracting additional products in the form of condensate, raising the throughput of gas pipelines and significantly reducing operating expenses associated with gas transportation. This is why the link in the single reservoir-well-gas field-consumer chain associated with gas treatment at the gas field and gas field construction has recently been playing an increasingly greater role in the development of deposits.

Low temperature separation is presently the principal process used in gas treatment at the country's gas-condensate deposits. This is the cheapest and technologically simplest method, in which low temperature is achieved through a natural drop in gas pressure. However, when deposits are developed to depletion, in the course of their exploitation the working pressures decline, the pressure drop at the throttle decreases, and a moment arises when it is impossible to achieve the separation temperature foreseen by the all-union standard through a natural pressure drop. This period requires introduction of artifical gas cooling resources--refrigerators, and as pressure declines further, achievement of the gas parameters required by the all-union state standard necessitates increasing the refrigerating capacity of refrigerators. If the separation pressure is below the pressure in the gas pipeline through which gas is fed to the consumer, a booster compressor station becomes necessary. Installation of expensive refrigerating and compressor equipment is not always economically justified, and it depends on the annual gas yield (that is, on the initial reserves), which determines the unit outlays. Moreover when each deposit is outfitted individually, the equipment does not operate under optimum conditions, owing to which its technological and economical effectiveness declines, which causes a decline in gas quality and in the condensate yield.

If deposits of the same gas bearing province possess relatively similar geological conditions, initial pressure, temperature, condensate content and so on, and if they are located near each other, they must be considered in their interrelationship and interdependence when planning their development and construction*--that is, the question of integrated planning of the outfitting of a group of deposits in a gas bearing province arises. When deposits are integrally outfitted, the need for building refrigerating units and booster compressor stations for each integrated gas treatment facility disappears: In this case only primary gas and condensate treatment is carried out at the deposits, while final treatment is performed at main interfield treatment facilities. In integrated planning, all deposits are tied in together by a single gas and condensate transportation system, which makes it possible to regulate gas extraction and the separation conditions at the integrated gas treatment facility, to determine the time to initiate operation of refrigerators, and to achieve faster introduction of new deposits into operation. When condensate is degassed at integrated gas treatment facilities of certain deposits, difficulties associated with utilizing gases produced by low pressure degasification arise, inasmuch as the quantity of such gases is relatively small while the outlays on their compression are relatively high. To reduce losses of condensate and of propane-butane fractions, a system of closed collection and transportation of unstable condensate is introduced at gas extracting enterprises; this is another reason why it would be suitable to carry out condensate treatment at main interfield facilities.

Integrated planning creates the need for utilizing cycling processes in certain horizons of some deposits. In this case gas may be treated right at the deposit or at common main facilities; dry gas may be additionally compressed and fed to the main compressor station for injection into the reservoir. The choice of the variant depends only on technical and economic considerations.

A variant of outfitting the Kotelevskoye deposit employing a cycling process was examined during the planning of experimental industrial operation of the Kotelevskoye-Berezovskoye group of deposits. Collection and treatment of the gas right at the deposits was recommended. Because it was impossible to initiate the work at all deposits in the group simultaneously, the schedule of their introduction and of gas withdrawal was calculated in such a way that the amount of gas handled by the main facility would remain constant in time. As new deposits are introduced, gas withdrawal must be adjusted in such a way (with a consideration for distances and pipeline diameters) that pressures at the input to the main facilities would differ insignificantly. The calculation procedure used to associate the gas treatment system with the system for developing a group of deposits and to account for their interaction in time requires further improvement and refinement.

Joint treatment of gas from a group of deposits may also be carried out in a later state of development, when the working pressures can no longer provide

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* Korotayev, Yu. P. and Zakirov, S. N., "Teoriya i proyektirovaniye razrabotki gazovykh i gazokondensatnykh mestorozhdeniy" [Theory and Planning of the Development of Gas and Gas-Condensate Deposits], Moscow, Nedra, 1981, 294 pp.

for the drop in gas temperature achieved by throttling to support operation of low temperature gas separation facilities. In this connection the equipment installed at the deposit to reduce pressure losses must be partially disassembled. This was the path followed in preparation of gas from the group of deposits serviced by the Krestishchenskiye main facilities, where refrigerators, booster compressor stations and other appropriate equipment for acquisition of high quality gas were installed.

Integrated outfitting of a group of gas-condensate deposits was first employed in the planning of the development of the Kotelevskoye-Berezovskoye group, which includes the Kotelevskoye, Berezovskoye, Ukrainskoye, Vodyanovskoye, Belousovskoye, Stepovoye, Kisovskoye and Karaykozovskoye deposits. Some of them have already been opened up (Kotelevskoye, Berezovskoye, Karaykozovskoye, Stepovoye), while exploration and prospecting operations are being carried out at others (Ukrainskoye, Belousovskoye), and exploration and prospecting operations are planned for the next few years in the Vodyanovskoye and Kisovskoye deposits. Moreover there are a few other promising areas in this region. Experimental industrial operation of the Kotelevskoye-Berezovskoye group of deposits was planned as if this was to be experimental industrial operation of a single large deposit, with gas and condensate being treated at main facilities.

Inasmuch as we do not have a clear procedure for determining the time of introduction of deposits into operation and the amounts of gas to be withdrawn from individual fields, it is recommended that the introduction of deposits be planned on the basis of the degree to which they have been investigated, the presence of operating wells and so on, with a small time interval (3 to 5 years).

The main producing horizons of the Kotelevskoye-Berezovskoye group of deposits are horizons in Namyurskoye and Vizeyskoye deposits. Each horizon can be distinguished as an independent entity inasmuch as its depth of occurrence, the initial reservoir pressures and the concentration of heavy hydrocarbons differ for each horizon. Two variants of developing this group of deposits were examined: 1) depletion development and 2) development using a cycling process at some deposits in the horizon of the Namyurskoye deposit, and depletion development of the horizon of the Vizeyskoye deposit.

A primary gas treatment facility (UPPG) is used to collect gas from wells at a deposit undergoing depletion development. Five UPPGs were planned: UPPG-1 (Belousovskoye, Vodyanovskoye and Kisovskoye deposits), UPPG-2 (Karaykozovskoye), UPPG-3 (Stepovoye), UPPG-4 (eastern part of the Berezovskoye deposit) and UPPG-5 (western part of the Berezovskoye deposit).

The Kotelevskoye deposit is to be developed using the cycling process; the total outfit of gas treatment equipment is to be set up right at the deposit. Gas is to be collected from the wells individually, without the use of a reservoir. Inasmuch as the wellhead pressure exceeds the permissible pressure for safe operation of gas pipelines, the gas must be throttled down to a pressure of 15.7 MPa; it will then be transported at this pressure to a UPPG, where preliminary liquid separation will be carried out in separators

with a productivity of 3 million m^3/day at a working pressure (with a consideration for losses in the connecting line) not exceeding the rated pressure for which the separation equipment is intended. The diameters of the connecting lines are 114 and 133 mm. The quantity of separators is determined on the basis of the daily yield of gas from the wells. An analytical separator is installed at the UPPG for well testing. Gas separated at the UPPG is then fed by a connecting gas pipeline to a common gas field gathering main, by which it is then transported to the main facilities. The system for feeding condensate and water from the UPPG to the main facilities is similar. At the main facilities, a low temperature separation unit upgrades the quality of the gas and condensate to the requirements of the all-union state standard.

Production lines with a productivity of 5 million m^3/day at a pressure of 8 MPa, consisting of a first-stage separator, shell-and-tube heat exchangers, and second-stage separator and dividers, are recommended. The quantity of production lines is determined by the productivity of the main facilities, assuming a separation pressure of 5.4-4.4 MPa. Maintenance of a pressure of 4.4 MPa makes it possible to lengthen the gas treatment time in accordance with norms of the all-union state standard, without having to use artificial cooling resources.

Condensate separated out in the first stage of the low temperature separation unit of the main facilities and condensate delivered from the UPPG are then fed into first-stage dividers ($P = 6.3$ MPa), where water is separated out together with corrosion and hydrate formation inhibitors. Condensate and saturated inhibitor (DEG) are fed to the second-stage divider ($P = 3.4$ MPa). After passing through the first- and second-stage dividers, condensate is degassed by reducing pressure in the containers to that in the condensate line (with regard for transportation losses), and then it is fed to a Seleshchin condensate stabilizing unit.

Gases obtained from degassing and from the first-stage divider are fed into the common flow of gas entering the low temperature separator; after gas-gasoline processing and compression, gases from the second-stage and condensate degassing containers are fed to the gas main.

The system proposed here for integrated outfitting of a group of deposits, in accordance with which gas and condensate are only subjected to primary treatment at the deposits, and final treatment is carried out at main interfield facilities, has a number of advantages over the traditional system foreseeing complete treatment of gas and condensate at each deposit. These advantages are, specifically: the system's maneuverability; the possibility for regulating the production parameters of the deposits in the group; faster commissioning of new deposits; longer time of operation of production equipment at main facilities under optimum conditions; utilization of gases produced in low pressure degasification; the possibility for compensating for a shortage of gas from one or several deposits in the group using the cycling process by gas from other deposits; reduction of the capital outlays on outfitting the UPPG owing to a decrease in the quantity of separation, heat exchange and other equipment required, and centralization of compressor stations and cooling

units at main interfield facilities; reduction of operating expenses. The system for withdrawing gas from the wells remains unchanged.

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OIL AND GAS

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UKRNEFT' ASSOCIATION PUBLISHES RESULTS OF OIL RESERVOIR STIMULATION

Kiev NEFTYANAYA I GAZOVAYA PROMYSHLENNOST' in Russian, No 3, Jul-Sep 84 pp 40-41

[Article by L. I. Kukhtevich and L. B. Grigorash, Central Scientific Research Laboratory, Ukrneft' Production Association: "Using New Equipment in Oil and Gas Extraction"]

[Text] Measures to introduce new extraction equipment and advanced extraction procedures implemented by the Ukrneft' Production Association in 1979-1983 produced an economic impact of 20.6 million rubles. The introduction results are shown in Table 1.

Table 1. Principal Measures for Introducing New Equipment and Advanced Procedures Implemented by the Ukrneft' Association in 1979-1983

(1) Группа мероприятий	(2) Количество мероприятий	(3) Дополнительная добыча нефти, тыс. т	(4) Экономический эффект, тыс. руб.
Воздействие на пласт (5)	4	532,3	9 451,0
» » призабойную зону скважин (6)	6	34,4	726,5
Оптимизация режима работы скважин (7)	1	186,0	6 178,4
Борьба с коррозией, парафино- и солеотложениями (8)	4	—	2 416,8
Автоматизация технологических процессов (9)	3	—	154,8
Охрана окружающей среды (10)	1	—	570,6
Прочие мероприятия (11)	7	31,8	1 069,9
Всего (12)	26	784,5	20 568,0

Key:
1. Group of measures
2. Number of measures
3. Addition oil extraction, thousands of tons
4. Economic impact, thousands of rubles
5. Reservoir stimulation
6. Stimulation of well bottom-hole zone
7. Optimization of well operating conditions
8. Control of corrosion and of paraffin and salt deposition
9. Automation of production processes
10. Environmental protection
11. Other measures
12. Total

Because exploitation of oil deposits is accompanied by a decline in reservoir pressure, measures aimed at increasing the final oil yield of the reservoirs occupy a special place. This article examines only those measures which have the greatest influence on the principal technical-economic indicators of the Ukrneft' association.

Measures to stimulate the bottom-hole zone of wells promote recovery of natural permeability or its augmentation. This group of measures include foam-acid treatment and thermal stimulation methods, implemented by the Ukrneft' association in 1979-1981.

Foam-acid treatment is distinguished from conventional treatment in that a surfactant (prevotsell) is added to prepared acid solution to be used in well treatment; at a quantity of 1-2 percent, this surfactant promotes good intake of drilling mud. As a result of foam-acid treatment, the rate of the reaction with rock slows down, making it possible to inject active acid into a remote part of a reservoir. This raises the permeability of the reservoir not only in the bottom-hole zone but also farther away. The inflow of fluid into the well increases as a result.

Thermal methods of stimulating the bottom-hole zone of wells are used in old depleted deposits having a high concentration of tars and paraffin, and possessing a reservoir temperature close to the paraffin crystallization point.

Judging from the data in Table 2, foam-acid treatment is the most effective of the methods described above.

In addition to the methods of stimulating the bottom-hole zone of wells listed above, the Ukrneft' association employed reservoir stimulation methods in 1979-1983. Among the numerous methods available in this direction, injection of gas at high pressure, steam and water containing surfactant solutions into oil reservoirs was employed.

Injection of gas into oil reservoirs had a favorable effect on development of menilite deposits in the Glubinnaya fold of the Bitkovskoye deposit: The rate of decline of reservoir pressure decreased. High pressure steam is injected into reservoirs of the Miriam section of the Borislavskoye deposit and the Urych section of the Skhodnitskoye deposit in order to raise oil yield.

One of the principal methods for increasing the oil yield from deposits being developed by means of flooding producing horizons is injection of water and surfactant solution. It is simple and universal, it does not require additional capital outlays, and it can be used on large producing horizons in various geological conditions. A solution consisting of a mixture of prevotsell and sulfanol is used as the surfactant.

The volumes and indicators for introduction of reservoir stimulation methods are given in Table 3.

Water and surfactant solutions were injected into oil reservoirs at the Starosamborskoye and Strutinskoye deposits. Despite the fact that this method

Table 2. Results of Stimulating the Bottom-Hole Zone of Wells

(1) Показатель	(2) Методы обработки	
	(3) Пенокислотная обработка	(4) Термическое воздействие
	(5) Периоды, гг.	
	1979–1983	1979–1980
(6) Количество скважино-операций	347	367
(7) Успешность, %	61,4	88,8
(8) Суммарная дополнительная добыча нефти, тыс. т	194,5	19,6
(9) Дополнительная добыча на успешную обработку, т	913,20	60,16
(10) Экономический эффект, тыс. руб.	5277,3	491,3
(11) В том числе:		
(12) на одну скважино-операцию	15,21	1,34
(13) » » успешную скважино-операцию	24,78	1,51
(14) Экономия эксплуатационных затрат, тыс. руб.	1940,5	223,5

Key:

1. Indicator
2. Treatment methods
3. Foam-acid treatment
4. Thermal stimulation
5. Periods, years
6. Number of well-operations
7. Sucessfulness, percent
8. Total additional oil extraction, thousands of tons
9. Additional extraction resulting from successful treatment, tons
10. Economic impact, thousands of rubles
11. To include:
12. Per well-operation
13. Per successful well-operation
14. Savings in operating expenses, thousands of rubles

Table 3. Results of Introducing Reservoir Stimulation Methods in 1979-1983

(1) Показатель	(2) Закачка в нефтяные пласты		
	(3) воды с растворами ПАВ	(4) газа под высоким давлением	(5) пара высокого давления
(6) Объем внедрения, тыс. м³	1738,2	1346,7	1013,3
(7) Суммарная дополнительная добыча нефти, тыс. т	47,3	260,4	47,3
(8) Экономический эффект, тыс. руб.	1764,3	1876,5	756,4
(9) В том числе на единицу внедрения, руб/тыс. м³	1015,5	1393,4	746,5

Key:

1. Indicator
2. Injection into oil reservoirs
3. Water with surfactant solutions
4. Gas, at high pressure
5. High pressure steam
6. Volume introduced, thousands of m^3
7. Total additional oil extration, thousands of tons
8. Economic impact, thousands of rubles
9. To include, per unit of introduction, rubles/thousands of m^3

Table 4. Effect of Measures to Introduce New Equipment and Advanced Procedures on the Principal Technical-Economic Indicators

(1) Показатель	(2) Годы	
	1979	1983
(3) Относительное увеличение добычи нефти, %	3,17	2,01
(4) Снижение эксплуатационных расходов, тыс. руб.	1532,8	1119,7
(5) Условное высвобождение численности, чел.	168,0	226,6
(6) Рост производительности труда, %	5,19	6,35
(7) Снижение себестоимости добычи 1 т нефти, руб.	0,21	0,23
(8) Экономический эффект, тыс. руб.	9201,3	2176,3

Key:
1. Indicator
2. Year
3. Relative increase in oil extraction, percent
4. Reduction of operating expenses, thousands of rubles
5. Conditional manpower reduction, persons
6. Growth in labor productivity, percent
7. Reduction of the cost of 1 ton of oil, rubles
8. Economic impact, thousands of rubles

was not employed extensively in the oil and gas extraction administration, injection of high pressure gas and steam into oil reservoirs produced a high economic impact.

Among the measures aimed at maintaining the oil output, optimization of the mechanized well fund using computers occupies a special place. The work of the mechanized well fund was optimized throughout all of the association's oil and gas extraction administrations, which made it possible to obtain additional oil with minimum outlays.

Indicators of Optimization of
the Mechanized Well Fund in 1979-1983

Number of well-operations	737
Economic impact, thousands of rubles	6178.4
To include:	
Per well-operation	8.38
Per successful well-operation	15.48
Savings in operating expenses, thousands of rubles	1716.2

The effect of measures for introducing new equipment and advanced procedures upon the Ukrneft' association's principal technical-economic indicators is shown in Table 4.

When development of deposits is accompanied by declining extraction, large-scale application of the new methods for increasing oil output makes it possible to stabilize oil extraction.

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OIL AND GAS

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ADVANCES IN WELL TESTING, LOGGING TECHNOLOGY SURVEYED

Moscow NEFTYANOYE KHOZYAYSTVO in Russian No 9, Sep 84 pp 8-13

[Article by V. V. Laptev, VNIIneftepromgeofizika (not further identified), and Yu. Z. Lyandres, Ministry of Petroleum Industry: "Prospects for Technical Progress in Oil Field Geophysics"]

[Text] The high rate of growth of the volume of drilling operations in petroleum industry is posing two extremely important problems before geophysicists: 1) raising the effectiveness with which geological and procedural problems of geological prospecting, well drilling and development of deposits are solved on the basis of geophysical information; 2) reducing well down time during geophysical research.

The main directions for solving these problems, which are to a certain extent contradictory in nature, are: developing and introducing highly productive surface and multiple-parameter integrated well apparatus as well as apparatus to support new, more effective methods; improving the required complexes of methods and procedures of bore-hole research.

Surface Apparatus and Equipment

Soviet and foreign experience shows that the first phase in the development of geophysical technology is characterized by widespread use of logging stations consisting of a laboratory equipped with analogue recorders and a hoist equipped with a mechanical-drive winch powered by the motor vehicle engine. Stations in which the laboratory and the hoist were set up separately in two motor vehicles enjoyed the greatest use in the Soviet Union for oil well research. In the second phase a transition was made to stations equipped with analogue recorders of geophysical information. The third phase is associated with wide introduction of computerized (program-controlled) logging stations equipped with a hoist having a winch powered hydraulically or electrically. Installation of all equipment on a single vehicle chassis or a modular execution, intended for permanent use in support of cluster drilling, are optimum for research on wells undergoing drilling.

In the meantime the experience of creation and series production of the new surface equipment requires adjustments in this succession of phases. First of all the period of use analogue laboratories and logging hoists with mechanical drive

has been unjustifiably long. Production of such hoists cannot be stopped by plants of the Ministry of Instrument Making, Automation Equipment and Control Systems until the 12th Five-Year Plan. For various reasons the LKTs-10 and LK-101 digital laboratories created in the 1970s have not enjoyed wide use, and therefore we cannot expect a mass conversion to new digital logging laboratories to occur at this time. The Ministry of Petroleum Industry's Oil Field and Field Geophysics Administration adopted a decision to begin production of Trias logging recorders and to supply them to series analogue laboratories beginning in 1981. By 1985 the number of detachments in the sector equipped with digital recorders will be about 30 percent of the total number of logging detachments. The conversion to digital recording will basically be completed in the 12th Five-Year Plan, making it possible to interpret all geophysical data with computers.

It will probably not be until the 12th Five-Year Plan that the plants will convert from production of analogue stations to assimilation of computerized stations, bypassing the digital laboratory production phase. Research and design organizations of the USSR Ministry of Petroleum Industry and the USSR Ministry of Power and Electrification are working on the design of computerized logging stations. The laboratory's built-in computer will make it possible to automate preparation of apparatus for measurements (for diagnosing and testing the station's systems and for calibrating the measuring channels), to program the recording, quality control and treatment of geophysical data and to automate hoisting operations. Highly productive work will be achieved in the use of computerized laboratories through the application of multiple-parameter integrated well apparatus and release of the operator from many laborious operations associated with preparing and conducting logging.

Acceptance trials of these laboratories and of a hoist with a hydraulic drive mounted on a KAMAZ-4310 motor vehicle chassis intended for researching wells up to 7 km deep are planned to occur in 1985. Self-propelled computerized stations equipped with a hydraulically driven winch, mounted on a standard chassis and intended for research on wells up to 4 km deep, will be assimilated by industry.

Well Apparatus

Several phases can also be distinguished in the development of well apparatus. The first of them basically came to an end in the 1960s, and it was characterized by mass use of one-method instruments coupled with simultaneous transmission of one or two parameters by a single cable strand. Two and three-method instruments and simultaneous transmission of up to four parameters by one cable strand came into wide use in the 1970s. The most significant factor responsible for the transition to this phase was creation of a reliable four-channel frequency-modulated (FM) telemetric system which enjoyed wide application in integrated electric logging instruments. A data transmission system in which the channels are separated in relation to pulse polarity and amplitude became widespread in radioactive logging. In this case the number of simultaneously operating channels did not exceed four as a rule. The second phase is characterized by a high level of integration of well apparatus, which is limited usually to the bounds of the methods of one physical nature. Instruments of this generation are widespread today, and they will apparently be in wide use until the late 1980s.

The third generation of well apparatus is now in its initial stage of development. Its characteristic features are:

the possibility for recording data by a significant number of methods, including those of different physical nature, by a single instrument;

use of a multiplex telemetric system (with over 20 channels);

the possibility for programmed control of the work of well instruments using a built-in surface computer;

wide application of the principles of aggregation when building well apparatus.

Efforts in this direction are already under way.

Let us examine the most important achievements in the different directions of research.

Electric Methods

Creation and mass introduction of complex apparatus for taking well measurements making it possible to simultaneously record data from lateral sounding (LS) and lateral logging (LL) was a great achievement in the development of these methods. In particular, El apparatus, which is under experimental production at the Special Design-Technological Bureau of Oil Field Geophysics (SKTB PG, Groznyy), enjoyed application in petroleum industry. About 1,500 instruments of this type are to be manufactured in 1977-1985, which will significantly raise both the technical level of the sector's geophysical enterprises and the productivity of the work of wells. In 1984-1985 the El instrument will be replaced by the improved KZ-741 instrument, intended for simultaneous LS, LL and resistivimetry. Enterprises of the USSR Ministry of Power and Electrification are using similar type ABKT apparatus.

Use of an FM telemetric system in this apparatus made it possible to unify the surface panel and create a series of well instruments operated by it on the basis of different electric methods. They include in particular type E temperature and pressure resistant instruments created by the SKTB PG and used in the Ministry of Petroleum Industry to conduct research on deep and ultradeep wells. In addition to the El instrument, the series now includes instruments used for standard logging and well caliper logging (K2-741), and induction logging (IL) and LL in single-sonde (E3M) and multiple-sonde (E6,E9) versions, and microlaterolog survey (MS) in wells with temperature T to 200°C and pressure p to 120 MPa (E2). A complex of instruments for wells with T=250°C and p=150-200 MPa is presently being created for this telemetric system. This will make it possible to basically solve the problem of studying deep deposits by a complex of modern electric methods.

A series of well instruments intended for research by electric methods and operated by a unified IPChM panel was widely introduced into enterprises of the USSR Ministry of Power and Electrification. In addition to ABKT apparatus,

these instruments include the BKS-2 (two lateral logging instruments), the MBK (MS+well caliper logging), the KAM (MS+two microlog sondes+well caliper logging), the AIK-M (IL) and the BIK-2 (two LL+two IL) with temperature and pressure resistance up to 150°C and 100 MPa.

Analyzing the present status of electric methods, some negative phenomena that have made themselves known should be noted. Use of a LS+LL+IL complex together with nonsaline drilling mud is the principal method employed in most regions to determine reservoir resistivity ρ_{Π} and consequently the oil saturation factor. Performance of such research requires considerable amounts of time. Replacement of this complex by a complex consisting of two IL+two LL is taking more time than it should, on one hand due to the absence of a sufficient volume of the appropriate apparatus, and on the other hand due to inadequate effectiveness of these methods under certain geological and production conditions (reservoirs with ρ_{Π}>80 ohms•m in wells with nonsaline drilling mud). Great difficulties arise in determining rock saturation in cases where reservoirs are flooded by low mineral content fluids. In this connection further efforts are necessary to develop and improve the complex of apparatus and the ways of interpreting electric methods. In particular there is interest in conducting dielectric logging (DL). In 1984 the VNIIneftepromgeofizika completed development of the DK1-713 apparatus to support this method. Its production is to be initiated in 1985 by an experimental production operation of the Tyumen SKTB [Special Design-Technological Bureau]. In 1984 the VNIIneftepromgeofizika has been conducting acceptance trials together with the Tatneftegeofizika [not further identified] on AEMK-1 electromagnetic logging apparatus which measures attenuation of the horizontal component of the magnetic field. Well research conducted with this apparatus at deposits of the Tatar ASSR and West Siberia demonstrated that in terms of the range of ρ_{Π} values that can be measured (0.5-200 ohms•m) and radial and vertical characteristics, electromagnetic logging has certain advantages over traditional forms of electric logging.

High frequency induction isoparametric sounding apparatus which will make it possible to obtain a more-detailed characterization of ρ_{Π} in the zone of penetration of drilling mud and in the unaltered part of the reservoir is also being developed.

Radioactive Methods

Creation and initiation of series production of density gamma-ray logging (DGRL) and compensated neutron logging (CNL) made it possible to include these methods into the composition of mandatory complexes for well research at enterprises of the Ministry of Petroleum Industry beginning in 1984. The high resolution of these instruments in determining porosity and lithological composition of rock will significantly the raise the effectiveness with which complexly structured reservoirs are studied.

Geophysical enterprises of the Ministry of Petroleum Industry are using RKS-1 apparatus for this purpose to conduct DGRL and gamma-ray logging (GRL), and RKS-2 apparatus (for CNL+GRL) and, in deep wells, PK1-941 (DGRL+GRL) and GK4-841 apparatus (two neutron logging--NL--systems+GRL). The RKS-3 apparatus (CNL+GRL+collar locator), which insures highly effective labor in well research, was created for the conditions of West Siberia. Similar research is being

conducted by enterprises of the USSR Ministry of Power and Electrification using RGP-2 (DGRL+GRL) and MNK-1 apparatus (CNL+GRL).

When reservoirs are flooded with weakly mineralized fluid, further development requires neutron pulse methods. Unfortunately the rate of work in this direction slowed down in recent years.

Progress in using radioactive methods for quality control of cementing is associated with wide introduction of SGDT-3 apparatus for DGRL. It makes it possible not only to monitor the quality of hydrated cement outside the casing but also to reveal defects in casings and to locating a coupling in relation to the cross section. Apparatus presently under development provides for effective control of cementing by lightened backfill mixtures.

Acoustic Methods

Considering the fast growth of drilling volume, the need has arisen for expanding production of improved acoustic logging apparatus by plants of the USSR Ministry of Instrument Making, Automation Equipment and Control Systems. Introduction of the following instruments, developed by organizations of the USSR Ministry of Geology for research on uncased wells, is planned: SPAK-6 (T=120°C, p=100 MPa, d=90 mm), SPAK-8 (T=150°C, p=100 MPa, d=90 mm) and SPAK-10 (T=200°C, p=150 MPa, d=90 mm). Introduction of the AK1-841 instrument (T=200°C, p=100 MPa, d=90 mm) designed by the SKTB PG is also planned. Cementing quality control will be carried out by means of TsMGA-2 apparatus (T=120°C, p=100 MPa, d=110 mm) developed by the VNIIneftepromgeofizika and produced by the Lvovpribor Plant. AKTs-4 apparatus is to be replaced by AKTs-A apparatus (T=150°C, p=100 MPa, d=80 mm). Introduction of MAK universal acoustic logging apparatus developed by the VNIIneftepromgeofizika for research on uncased and cased wells will begin in the 12th Five-Year Plan.

Now that SAT apparatus is in series production, acoustic video logging is employed in many regions of the country to reveal defects in strings and to control perforation intervals. The scale of use of the method for well overhaul is apparently widening significantly. The SAT-2 instrument is presently being developed with an orientation system and a device for recording the amplitude-time characteristics of a reflected signal.

Successes in the theory of acoustic logging, achievements in ultrasonic equipment and technology, development of digital recording of wave patterns during logging and the possibility of processing them with portable and permanent computers are promoting effective use of acoustic methods.

Reservoir Dipmetering

Series production of the NID-1 dipmeter and the Trias digital recorder as well as software for computer processing of well measurements created favorable conditions for wide introduction of reservoir dipmetering. Since 1984 the method has been within the composition of mandatory complexes for studying exploratory wells in the Ministry of Petroleum Industry. While experience in

using this complex together with seismic prospecting is still low in quantity, it does suggest that there are great possibilities for raising the effectiveness of geological prospecting carried out to reveal lithological and stratigraphic formations and to study revealed structures by seismic methods. Dipmetering may be employed both in wells drilled into platform-type deposits and in geosynclinal areas.

Well Directional Surveying

Because of the great volume of slant drilling being carried out in the Ministry of Petroleum Industry, the problem of directional surveying, which is associated with significant outlays of time and insufficient accuracy of measurements in the shaft, as well as with the difficulties of determining the curvature of cased wells, came into being.

Transition from taking measurements at individual points to continuous recording of curvature parameters turned out to be possible following creation of the IN1-721 digital inclinometer. Its production is to begin in the current five-year plan. The advantages of the IN1-721 instrument include higher measuring speed and accuracy, the possibility for work in wells with a slant angle greater than 60° and the objectivity with which the obtained results are documented. However, use of such an instrument is labor-intensive when well crookedness increases, and it requires additional idle time for taking the measurements. Use of a bottom-hole inclinometric system that records curvature without disturbing the drilling process would be more promising in this case. Specialists of the VNIIGIS and the VNIIneftepromgeofizika are working on the design of such systems. Acceptance trials are planned for 1984-1985.

The VNIIneftepromgeofizika is developing a gyroscopic inclinometer for determining the trajectory of cased wells or curvature by taking measurements through drill pipes. In 1983 the first successful measurements were taken by this instrument in a cased well at Samotlor, and its acceptance trials are planned for 1986.

Metrological Support

A metrological service which supplies the necessary technical and methodological resources of metrological support to geophyical enterprises has been functioning in such enterprises of the Ministry of Petroleum Industry since 1977. Fifteen types of testing units have been designed for apparatus used in bore-hole research and in control of development of deposits and of the technical condition of wells. Unfortunately their manufacture and delivery to the trusts proceeds slowly sometimes, because construction of an experimental production operation of the VNIIneftipromgeofizika has been delayed. A program for building and placing monitor wells into operation is being implemented more efficiently in the Ministry of Petroleum Industry (25 are functioning, 10 are under construction). They made it possible to significantly raise the quality of geophysical information in general in the sector. Efforts to build and outfit regional metrological centers in Ufa, Groznyy and Nizhnevartovsk and to supply geophysical trusts with testing units are continuing.

Complexes and Procedures of Geophysical Research, Their Interpretation

In 1984 the Ministry of Petroleum Industry will introduce the improved "Standard and Mandatory Complexes of Geophysical Research on Exploratory and Operating Wells Drilled for Oil and Gas." Application of this document will significantly raise the effectiveness with which the geological problems of exploring and developing deposits are solved, and it will make it possible to drill wells more effectively. Replacement of obsolete methods by new, more effective ones will play the main role in this case. In particular, gas logging will be replaced by geological-technological research and by neutron gamma-ray logging. Apparatus for density DGRL, reservoir dipmetering and so on will be introduced into the complexes. The objective is to introduce these complexes as quickly as possible, to insure that all enterprises follow the associated methods strictly and to develop the most effective procedures of integrated research.

Significant progress became evident in recent years in assimilation of methods for computer interpretation of the results of geophysical research by the enterprises. It all began when the Ministry of Petroleum Industry's geophysical enterprises were equipped with modern data processing, storage and transmission resources and when the necessary software was created. As introduction of digital recording assumes a major scale, transition to computer interpretation will accelerate significantly. Computers are already being used in West Siberia to interpret over 50 percent of the bore-hole research data.

The problems of studying complexly structured reservoirs and determining oil and water saturation of rock in the presence of weakly mineralized reservoir water will continue to be the principal ones in development of interpretation methods in the next few years.

New possibilities for well geophysical research should reveal themselves with seismic prospecting. Joint interpretation of data acquired by seismic prospecting and geophysical methods will make it possible to solve such problems as exploring and prospecting unstructured oil and gas deposits more effectively, predicting zones of abnormally high reservoir pressure and determining the physicomechanical properties and structure of rock. This will permit us to raise oil field geophysics to a new technical level.

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OIL AND GAS

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AUTOMATED WELL CONSTRUCTION PLANNING OFFERS ADVANTAGES

Moscow NEFTYANOYE KHOZYAYSTVO in Russian No 9, Sep 84 pp 13-14

[Article by V. B. Rezchikov, TatNIPIneft': "Advantages of Automated Planning of Well Construction"]

/Text/ The TatNIPIneft' /Tatar State Scientific Research and Design Institute for the Oil Industry/ has now converted completely to computerized planning of well construction. This became possible owing to development and introduction of an automated well construction planning system (SAPR-bureniya) at the institute. Automated planning has advantages over traditional methods in practically all phases of drawing up the planning estimates, and it widens the possibilities of planners for improving the quality of their planning estimates.

Group plans for well construction also presuppose group accuracy of both the initial and resulting data--that is, the permissible range of the values of the parameters employed is sufficiently large. These conditions are satisfied by group planning of well construction without the use of computers. The advantage of group planning is that a collective of 10-15 planners can draw up planning estimates for the drilling of about 1,000 wells a year. The shortcoming is that in addition to averaging the estimated cost of construction of wells within the group, the technological concepts are averaged as well, making it necessary for the drilling organizations to tie in the planning estimates to each well they drill. Moreover it is impossible to indicate group accuracy for parameters such as the intervals and intensity of collapses, circulation losses and water, oil and gas ingresses. For the plan and the cost estimates to be realistic, we need to have maximally reliable data at least for these parameters.

The actual cost of a drilled well differs significantly from the estimate based on a group plan; this makes it necessary to adjust the cost of well construction with regard for the actual geological-technical conditions. According to the sector's technical policy drilling enterprises must be converted to the financing of drilling operations on the basis of the plans--that is, without adjusting for the actual geological-technical conditions. This presupposes improving the quality of technical planning of well construction, and thus raising the role of the plan in drilling as a technological document: Up until now, for practical purposes the plan has only be used as a basis for financing drilling operations. The main goal of developing the SAPR-bureniya was to

make individual plans possible. A group plan foresees development of an individual plan in relation to all parameters for a well that is treated as the average for the given group.

To reduce the difference between the estimated and actual cost of well construction and to raise the quality of planning decisions, in the opinion of the author it would be suitable to implement the following measures.

1. Reduce the number of wells included in a group plan.

2. Include a section in the group plan concerned with the procedures of preventing and eliminating complications in the drilling process.

3. Develop the technological concepts associated with preventing and eliminating complications individually for each well, as a supplement to the group plan.

Reduction of the number of wells within a group will doubtlessly raise the accuracy of the planning concepts, but this will also inevitably cause an increase in the volume of the planning work and make it necessary to hire additional planners. Introduction of the SAPR-bureniya in the TatNIPIneft' made it possible to reduce the planner staff by 23 persons. The main advantage of automated planning is that when its volume increases and the geography of the drilling operations does not expand, only the computer time of the system increases, with the planning staff remaining unchanged. This can be explained by the fact that when raw data are available for a particular drilling area, specific planning for one well is based on a prediction of the entire geological cross section, and on calculation of its profile and technological indicators. To draw up a plan for another well in this same area, we need only to indicate its coordinates, the altitude of the mouth and the data for determining the planning profile, and repeat the calculations using a computer. There are good technical grounds for stating that automated planning does raise the accuracy of planning concepts.

Inclusion of a section into the well construction plan on the technology of preventing and eliminating complications in the drilling process will make it possible to account for additional consumption of materials (cement, filler, bentonite and so on) and extra time outlays on these operations, which will reduce the difference between the estimated and actual cost of well construction.

In order to implement the third measure--that is, to develop the procedures for preventing and eliminating complications, we need to predict the intervals and degree of complications and, on the basis of an analysis of this information, to select the appropriate procedures for preventing or eliminating complications. This work would be practically impossible without computers because of the large volume of information and calculations. Such a possibility does exist in the SAPR-bureniya*, but this section is not foreseen in the

*Rezchikov, V. B., Abdrikhmanov, G. S., Meling, K. V. and Blinova, N. I., "Justification of Planning Concepts Associated with Isolating Absorbing Horizons in the Automated Well Construction Planning System," RNTS AVTOMATIZATSIYA I TELEMEKHANIZATSIYA NEFTYANOY PROMYSHLENNOSTI, Moscow, VNIIOENG, No 11, 1980, pp 8-10.

"Model of a Technical Plan for Construction of Oil and Gas Wells" (RD 39-2-262-79), even though the document was written with regard for operation of the SAPR-bureniya. If inclusion of this section in the group plan will reduce the difference between the actual and estimated cost of well construction, then issue of a geological-technical order and information on procedures to prevent and eliminate complications as a supplement to the plan for each well would make it possible to basically avoid such complications and preplan the organizational measures necessary for their successful elimination.

Conclusions

1. The accuracy of technological concepts used in group planning may be raised by reducing the volume of wells contained in the group.

2. When the SAPR-bureniya is used in planning, growth of the planning volume without expansion of the geography of drilling operations would lead to an increase in computer time without any change in the planning staff.

3. Computer prediction of the intervals and degree of complications in drilling will make it possible to reduce the difference between the estimated and actual cost of well construction.

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OIL AND GAS

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CYCLIC RESERVOIR FLOODING METHODS COMPARED

Moscow NEFTYANOYE KHOZYAYSTVO in Russian No 9, Sep 84 pp 23-27

[Article by A. K. Mukhametzyanov, N. I. Khisamutdinov and G. Z. Ibragimov, Tatar ASSR Petroleum Industry Association: "Simple and Combined Physicochemical Cyclic Flooding"]

[Text] Increasingly larger numbers of oil deposits have been developed using depletion drive in recent years. This is why the search for methods by which to raise oil output is an important national economic task. The known methods of increasing the oil output of reservoirs may be divided into two groups: 1) thermal; 2) chemical and physicochemical. Methods in the second group combined with displacement by water are the most promising for large deposits.

Cyclic flooding combined with physicochemical action underwent industrial testing at deposits of the Tatar ASSR. Cyclic flooding has been in use in the sector for many years now, and a certain amount of experience has been accumulated with this method [1]. Improvements are continually being made on this method. During tests carried out with this method, the periods of rising and falling pressure were established by reducing and increasing the pumping volume of cluster pumping stations without shutting them down, and the load carried by the cluster pumping stations under these conditions was varied within a rather wide range, making it possible to establish a certain law between the time of greater and lesser injection.

This flooding procedure was introduced at the Bavlyneft NGDU [Petroleum and Gas Extraction Administration]. The object of the testing was the Bobrikovskiy horizon of the Bavlinskoye deposit. It is located in the northwestern part of the deposit, and it is made up of three continguous intrusion blocks serviced by three injection and 21 producing wells that have been subjected to cyclic action since 1981. Each block is characterized by a certain geological structure.

Block 1: The injection well is 375 m from the outer current oil-water contact, and its action extends to seven producing wells, which were characterized by the following parameters at the moment intrusion was initiated: total oil yield--100-120 tons/day, total water yield--500-550 tons/day, average rate of water encroachment--81-83 percent.

Block 2: The action of the injection well, which is 625 m from the outer current oil-water contact, extends to seven producing wells with a total oil yield of

90-115 tons/day, a total water yield of 510-550 tons/day and an average water encroachment rate of 83-86 percent.

Block 3: The action of the injection well, which is 750 m from the outer oil-water contact, extends to four producing wells having a total oil yield of 47-59 tons/day, a total water yield of 47-49 tons/day and an average water encroachment rate of 46-51 percent.

Viewing these blocks as a single intrusion system, we can note that in general it has been experiencing a stage of progressive of water encroachment. The total oil yield from 21 wells was maintained at approximately a constant level (7,300-8,800 tons/month) for 2-3 years as a result of intensive growth in injection volume of the adjacent injection wells. Later on, when conventional flooding was initiated, oil extraction began a stage of a sharp decline. Introduction of the cyclic flooding method averted this process. Seven injection cycles were carried out; their basic parameters are given in Table 1.

Table 1

(1) Параметр	(2) Цикл						
	I	II	III	IV (пауза) (3)	V	VI	VII
Объем закачки, (4) $м^3$/сут:							
максимальный (5)	1325	1380	1373	1312	1463	1457	1343
минимальный (6)	1250	1230	1200	1275	1330	1260	1190
Степень: (7)							
загрузки (8)	1,06	1,12	1,14	1,025	1,10	1,16	1,13
разгрузки (9)	0,96	0,93	0,91	0,98	0,94	0,9	0,92

Key:

1. Parameter
2. Cycle
3. Pause
4. Injection volume, m^3/day
5. Maximum
6. Minimum
7. Degree of
8. Loading
9. Unloading

The average injection rate in the period preceding intrusion, which was equal to the cycle duration (90 days), was 1,220 m^3/day, while in the intrusion period (on the average in seven cycles) it was 1,240 m^3/day--that is, the injection volume remained at its previous level, but in comparison with the longer preceding period it decreased by 8.5 percent. Within a single cycle, the half-periods of rising and falling pressure were varied from 30 to 60 days. The effectiveness of using the cyclic method was assessed by a known procedure [1] based on comparing the predicted curve of water and oil accumulation (for conventional flooding) and the actual curve. The results are shown in Figure 1, analysis of which would reveal that cyclic power stimulation produces a significant impact. In contrast to conventional cyclic flooding, cyclic power stimulation is characterized by a multiple (binary) effect. It is expressed graphically as a multiple change in the slope of the curve $\Sigma Q_н = f(\lg Q_в)$ (see Figure 1).

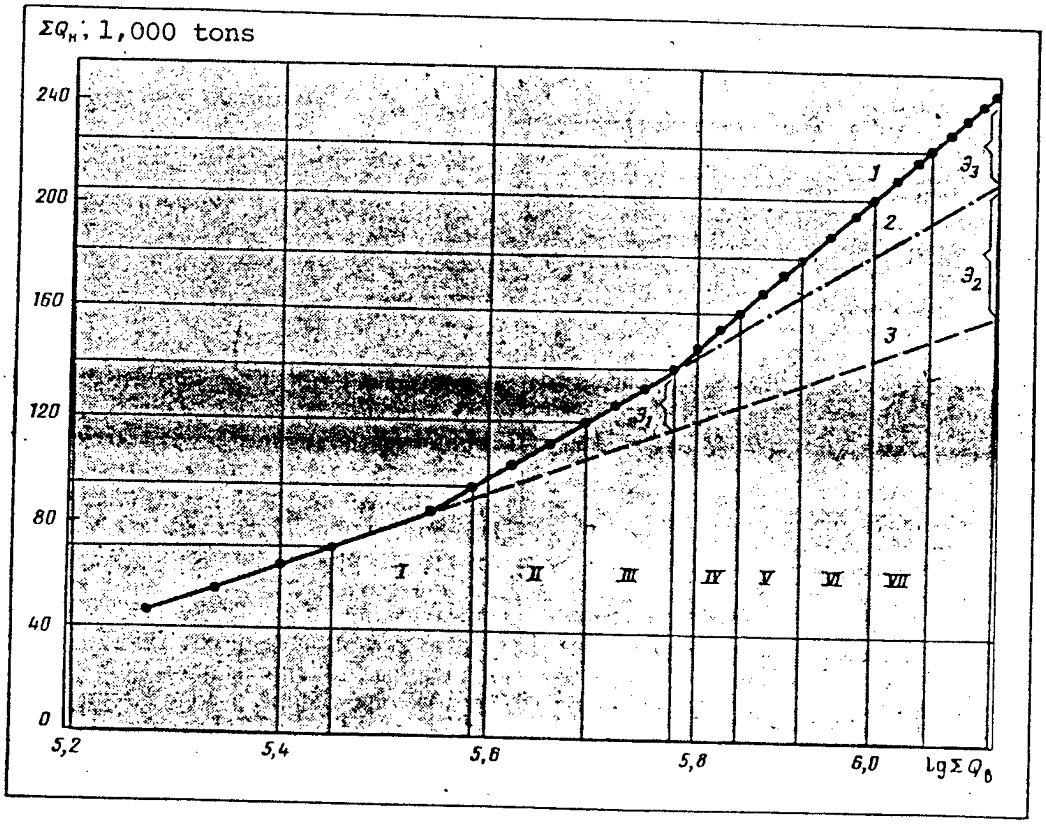

Figure 1. Dependence Between Accumulated Volumes of Oil ΣQ_H and Water ΣQ_B (thousands of tons) For the Intrusion Zone: curves: *1*--actual; *2*, *3*--predicted for cyclic and conventional flooding respectively

The increment of accumulated oil extraction (the impact) resulting from the first three cycles was $Э_1$=24,000 tons at the moment the fourth cycle began. The increment by the end of the assessed period after the first three cycles was $Э_2$=50,000 tons. But this increment cannot be obtained just by cycles *I-III*. The impact from the last four cycles was $Э_3$=30,000 tons, and the total added yield ($Э_2$+$Э_3$) is 80,000 tons.

The added yield resulting from introduction of cyclic flooding is significantly increased when this method is combined with physicochemical stimulation [2]. Reagent is pumped in with the purpose of creating a fringe alternating with buffer fluid. In the beginning, to reduce capillary effects in the reservoir, a solvent or some oil flushing solution is pumped into the injection well, followed by thickened PAA [not further identified] solution. The number of fringes can be varied from one to five or six. The thickened solution equalizes the intake rate profile, which increases the amount of the reservoir that is subject to displacement.

The physicochemical cyclic stimulation method was introduced at the Bavlyneft' NGDU. Two zones in the western part of the Bavlinskoye deposit (the Bobrikovskiy horizon), each having an area of about 100 ha, were selected for

Table 2

(1) Участок	(2) Цикл	(3) Фаза	(4) Закачиваемый раствор	(5) Массовая доля реагента С, %	(6) Относительная вязкость μ	(7) Объем закачки, м³	(8) Продолжительность работ, сут	(9) Среднее давление нагнетания, МПа	(10) Расчетная амплитуда давления, МПа
(11) Первый (скв. 925)	0	—	(18) ПАВ	2,7	—	2660	18	—	—
	I	(14) Вторая	(19) ПАА	0,035	1,7	102	1	9,0	—
		(15) Третья	ПАВ	1,6	1,0—1,1	1780	9	10,5	5,3
		(16) Четвертая	ПАА	0,06	4,8	120	1	10	—13,8
		(17) Пятая	(20) Вода	—	1,0	3600	9	11,0	—
	(13) Промежуточный	—	ПАВ	3,7	—	600	2	10,5	—
		Вторая	ПАА	0,04	2,2	120	1	10,0	—
		Третья	Вода	—	1,0	1200	3	11,0	6,0
	II	Четвертая	ПАА	0,065	4,2	200	1	11,0	—11,8
		Пятая	Вода	—	1,0	600	2	11,5	—
(12) Второй (скв. 917)		—	ПАВ	2,7	—	2840	—	11,0—11,5	
		Вторая	ПАА	0,04	1,8	200	—	11,0—11,5	0
	0	Третья	ПАВ	2,5	1,0—1,2	1830	—	12,0	0
	I	Четвертая	ПАА	0,06	4,0	250	—	10,5	0
		Пятая	Вода	—	1,0	600	—	11,5	—

Note: These indicators were obtained in the first stimulation series.

Key:

1. Zone
2. Cycle
3. Phase
4. Injected solution
5. Reagent proportion by weight, C, %
6. Relative viscosity μ
7. Injection volume, m^3
8. Operation time, days
9. Average injection pressure, MPa
10. Calculated pressure amplitude, MPa
11. First (well 925)
12. Second (well 917)
13. Intermediate
14. Second
15. Third
16. Fourth
17. Fifth
18. PAV [not further identified]
19. PAA
20. Water

study. The first zone includes one injection and five producing wells that are an average of 300 m from the injection wells. Six producing and one injection wells are located in the second zone. The principal planned injection indicators are given in Table 2.

An increase in the operating thickness of the exposed part of the reservoir was the immediate result (Figure 2). Physicochemical cyclic stimulation carried on for one complete series (in the zone covered by well 925) increased the yield and reduced the water encroachment rate of the oil wells (Figure 3). Similar results were obtained in the zone of well 917. The lower positive impact in this case can be explained by the fact that stimulation was not conducted fully so that these series could be compared.

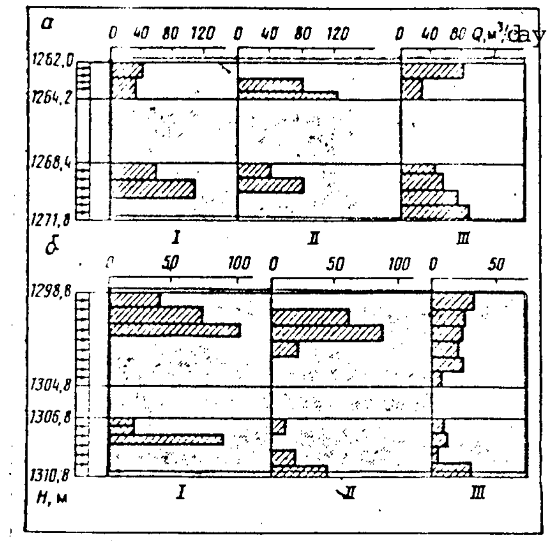

Figure 2. Change in Distribution of Injection Q with Respect to Reservoir Thickness as a Result of Physicochemical Cyclic Stimulation (*H*--depth, m; arrows indicate perforation intervals): *a*--well 925; *b*--well 917; *I*, *II*, *III*--correspondingly before, during and after introduction

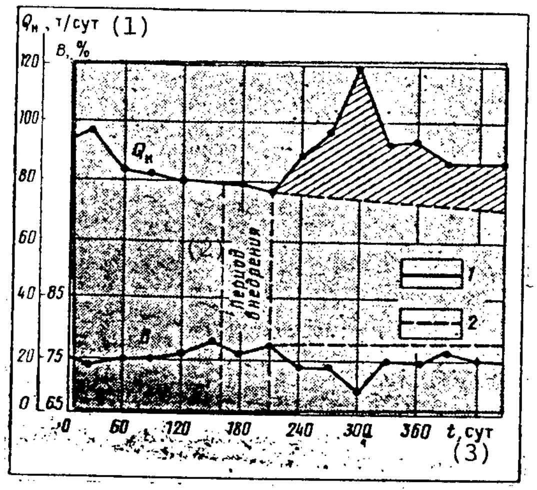

Figure 3. Change in Total Yield from Oil Wells Q_H and Rate of Water Encroachment *B* in time *t* Before and After Introduction of the Physicochemical Cyclic Stimulation Method: Curves: *1*--actual; *2*--predicted

Key:

1. Tons/day
2. Intrusion period
3. Days

According to these results the minimum number of functional cycles of a stimulation series must be not less than two.

The method of simple physicochemical cyclic stimulation consists of a larger number of phases, it is characterized by a higher frequency of stimulation, and it provides for a larger range of pressure variation than does cyclic power stimulation. It is characterized by a pressure rise phase that is always significantly shorter than the pressure fall phase.

The outlays on introducing the method are limited by the relationship

$$\Sigma\Delta Q_{H} \geqslant \frac{\sum_{1}^{n} V_{p_i} 3p_i + \Delta B}{Ц_{H} - C_{H}},$$

where $\Sigma\Delta Q_H$--total accumulated volume of additionally extracted oil; V_{pi}--volume of reagent i injected; $3p_i$--outlays on injecting 1 ton of reagent i; ΔB--additional outlays on rebuilding the flooding system; $Ц_H$--oil wholesale price; C_H--cost of extracting 1 ton of oil.

Physicochemical cyclic power stimulation of a reservoir requires a certain increase (15-20 percent) in the injection capacities. This makes it possible to redistribute the injection volume in times of loading and unloading, and to maintain the planned injection volume over the area or deposit. The method is very promising and economical; however, its application is associated with significant expenditure of effective chemical reagents, and with reconstruction and improvement of flooding systems.

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OIL AND GAS

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IN SITU COMBUSTION EXPERIMENTS CARRIED OUT WITH UZEN OIL

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[Article by L. A. Nagornyy, S. S. Blokh, V. V. Gnatchenko and A. K. Kashin, MINKH i GP: "Experimental Study of In-Situ Combustion in Application to Horizon XIV of the Uzen Deposit"]

[Text] It was concluded from a comparison of the actual parameters of in situ combustion [1] and recommended parameters [2] that investigation of the applicability of this method to raising the oil output of horizon XIV at the Uzen deposit might be suitable (Table 1).

Table 1

Parameter	Recommended	Actual
Reservoir thickness, m	>3	28
Depth of occurrence of productive reservoir, m	<2,100	1,150
Oil density, kg/m^3	>870	856
Oil viscosity, mPa•sec	>10	4
Porosity of terrigenic reservoir	>0.12	0.28
Permeability, μ^2	>0.1	0.3
Oil saturation	>0.4	0.7

It is evident from Table 1 that the viscosity of Uzen oil is relatively low within the reservoir; however, experiments carried out with in situ combustion at deposits containing low viscosity and light oils have been known to be successful [3,4].

Experimental research was conducted on in situ combustion in application to horizon XIV of the Uzen deposit in two directions: 1) comparison of data from "dry" and "wet" in situ combustion using oil from this horizon and a rock model constructed out of quartz sand; 2) study of the combustion process, once again using oil and polymictic sandstone from the Mangyshlak Peninsula.

This article presents the results of the first phase of the research, in which the possibility of organizing in situ combustion in horizon XIV of the Uzen deposit was evaluated. It was for this reason that a porous medium consisting of pure quartz sand from the Lyuberetsy quarry was used in the experiments.

Before running the experiments using published procedures [5,6], we determined the capacity of oil from horizon XIV to form residual fuel.

The quantity of residual fuel F was determined using graphs plotted by J. P. Alexander and other researchers, and four parameters of the oil: density ρ at a temperature of 20°C, viscosity ν at a temperature of 55°C, coking capacity K and atomic ratio H/C; residual fuel was also determined using L. A. Nagornyy's graphs and two parameters--ρ and oil saturation S_H at an air consumption rate of 200 m^3/m^3. The calculation results are given in Table 2.

Table 2

Residual Fuel Quantity Determined By										
Graphs								Formulas		
J. P. Alexander et al					L. A. Nagornyy			Alexander et al.	Rodriguez	Wohebier
$F=f(\rho)$	$F=f(\nu)$	$F=f\left(\frac{H}{C}\right)$	$F=f(K)$	F_{cp}	$F=f(\rho)$	$F=f(S_H)$	F_{cp}			
$\frac{0,72}{17,3}$	$\frac{0,79}{18,7}$	$\frac{1,22}{29,3}$	$\frac{0,75}{18,0}$	$\frac{0,87}{20,9}$	$\frac{0,73}{17,5}$	$\frac{0,75}{18,0}$	$\frac{0,74}{17,8}$	$\frac{0,85}{20,4}$	$\frac{0,74}{17,8}$	$\frac{0,518}{12,4}$

Note: F is given in units of % of rock weight in the numerator, and kg/m^3 of rock in the denominator.

The concentration of fuel in rock was also estimated experimentally for oil of horizon XIV at the Uzen deposit using methods developed by the MINKh i GP [Moscow Institute of Petrochemical and Gas Industry imeni Academician I. M. Gubkin]. Depending on the conditions, F was 16.5-22 kg/m^3 of rock [7].

During the experiments the core holder was filled with a previously prepared mixture of sand, oil and water. The porous medium can be described as follows:

Particle concentration, %, with following dimensions, mm:	
over 0.315	3
0.315-0.2	70
0.2-0.1	20
0.1-0.05	6
less than 0.05	1
Porosity, %	33.4
Permeability, μ^2	
for air	1.7
for water	1.4
Density, kg/m^3	1,810
Oil saturation, %	80

After the device was assembled and secured, the reservoir temperature was established in the model using sectional heaters. Then an electric heater located within the first zone of the core holder was switched on. After a certain while air was fed into the model at a rate of 0.06-0.12 m^3/hr, and the required counterpressure was generated at the outlet of the core holder. A temperature of 200-220°C was reached in the first zone of the model by initiating combustion, which required an increase in the air consumption rate to 0.9-1.2 m^3/hr. After a stable burning front was achieved, the electric heater was switched off, and the air consumption rate was reduced to its operating value of 0.6-0.8 m^3/hr. For "wet" in situ combustion, water was fed in after the burning front advanced 5-10 cm from the initiation zone. The prescribed water-air ratios were 0.0005, 0.001 and 0.0015 m^3/m^3. Advance of the burning front was recorded by measuring temperature along the length of the core holder with respect to time. Gases escaping from the model were analyzed for CO_2, O_2 and CO every 10-15 minutes. The quantity of escaping gases was measured by GSB-400 gas counters. The results of the experiments are given in Table 3.

Table 3

(1) Водовоздушное отношение, м³/м³	(2) Плотность потока закачиваемого воздуха, м³/(м²·ч)	(3) Скорость фронта горения, м/ч	(4) Удельный расход воздуха, м³/м³	(5) Коэффициент использования кислорода, %	(6) Удельный расход кислорода, м³/м³	(7) Концентрация сгорающего топлива, кг/м³
0	139,64	0,472	264	80,4	38,15	15,61
0,00105	107,3	0,318	337,4	79,0	53,37	17,75
0,0009	107,4	0,325	330,6	87,7	57,99	19,72
0,00043	123,7	0,366	337,4	91,3	61,59	19,37
0,00149	108,89	0,4	272,2	87,0	47,34	12,39

Key:

1. Water-air ratio, m^3/m^3
2. Injected air flow density, $m^3/(m^3 \cdot hr)$
3. Rate of advance of burning front, m/hr
4. Relative air consumption m^3/m^3
5. Oxygen utilization factor, %
6. Relative oxygen consumption, m^3/m^3
7. Concentration of burning fuel, kg/m^3

The results of several experiments with "dry" combustion showed that this process was unstable. The temperature of the burning front dropped quickly, and after it passed about the 70 cm mark (half the length of the reservoir model), burning ceased. This can be explained first of all by the low quantity of heat generated owing to the inadequate coking capacity of oil from horizon XIV, and secondly by the large heat losses into the environment. According to research conducted earlier by the MINKh i GP, the maximum quantity of coke-like residue formed by oil from horizon XIV is 21.8 kg/m^3 of dry rock, which is inadequate for "dry" combustion.

Figure 1 shows profiles of temperature T in relation to the length of the reservoir model L for "wet" combustion. It is evident from Figure 1 that the process was relatively stable, and that the front advanced from the heater to the outlet of the model. With "wet" combustion the heat that remained behind the burning front during "dry" combustion is transported into the region before the burning front, thus improving the temperature conditions in this zone. The front of evaporation constantly keeps up with the burning front, and the extent of the high temperature zone decreases (see Figure 1).

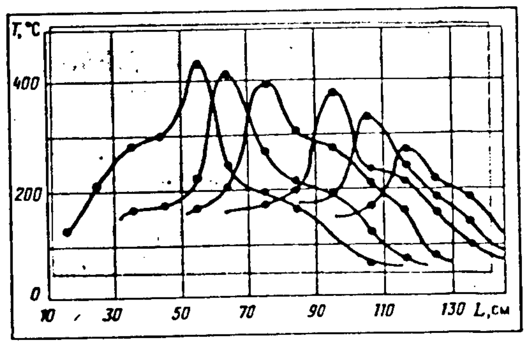

Figure 1. Temperature T Distribution Profiles for "Wet" in situ Combustion

Figure 2*a* shows the dependence of the concentration of burning fuel c_{CT} on the water-air ratio. It is a curve with a maximum at a water-air ratio of 0.0008-0.0009 m^3/m^3. The results differ from those arrived at in experiments by other researchers [2], whose similar dependency reflected a tendency for decrease in the quantity of burned fuel with growth in the water-air ratio.

As the water-air ratio grows, the rates of advance of the burning fronts and convective heat transport balance out, which improves the temperature conditions in the zone of residual fuel formation, and as a consequence its quantity increases. This confirms that the quantity of fuel that is burned increases. With further growth in the water-air ratio the rate of convective heat transport begins to exceed the rate of advance of the burning front, as a result of which partial extinction of the process occurs, the length of the vapor zone increases, and oil discharge rises in such a way that by the moment the zone of higher temperature approaches, almost no components that may serve as raw material for coke formation (even in normal conditions the quantity of such components is inadequate) remain in the reservoir.

Figure 2*b* shows the dependence of relative air consumption q_B on the water-air ratio. The largest value of q_B corresponds to a water-air ratio of 0.0005-0.0009. The tendency for change in the oxygen utilization factor follows the basic tendency for change in the indicators under consideration here: It is lowest with "dry" combustion and a water-air ratio of 0.00105, and it is largest in a water-air ratio range of 0.0005-0.0009. Because the air flow

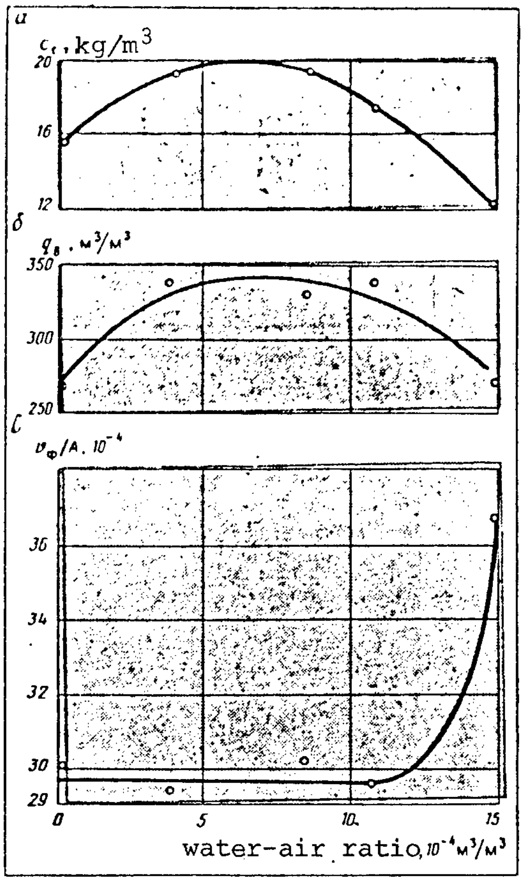

Figure 2. Dependence of the Concentration of Burning Fuel c_{CT} (*a*), Relative Air Consumption q_B (*b*) and the Ratio of the Rate of Advance of the Front of Combustion to the Density of the Injected Air Flow V_{Φ}/A (*c*) on the Water-Air Ratio

densities were lowest and the concentrations of burning fuel were somewhat larger at a water-air ratio of 0.0009-0.00105, the rate of advance of the burning front was lowest in this interval of water-air ratios (see Table 3, Figure 2*c*).

It is evident from Figure 2*c* that a sharp increase in the rate of advance of the burning front occurs only at a water-air ratio of 0.0015 when the air flow density remains practically constant.

The following was established as a result of the experiments conducted with oil from horizon XIV of the Uzen deposit and a rock model created out of quartz sand.

1. "Dry" combustion is unstable, apparently owing to the low coking capability of this oil.

2. "Wet" combustion at a water-air ratio of 0.0015 is also unstable, probably as a result of intensive transport of heat out of the combustion zone and rapid decrease of oil saturation before the burning front.

3. Stability of in situ combustion is achieved at a water-air ratio of 0.0009-0.00105; two of the most important indicators--air flow density and the rate of advance of the burning front--assume values close to those obtained for other deposits at which experimental industrial operations associated with introducing in situ combustion have been planned.

The investigation of the possibilities for creating and carrying out in situ combustion processes in porous media consisting of polymictic sandstone from Mangyshlak Peninsula and oil from horizon XIV will be continued.

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TATNEFT' ASSOCIATION REDUCES OPERATING EXPENSES

Moscow NEFTYANOYE KHOZYAYSTVO in Russian No 10, Oct 84 pp 3-6

[Article by N. Kh. Khamidullin, Tatneft': "Ways of Reducing Operating Expenses"]

[Text] Tatneft' [Tatar ASSR Petroleum Industry Association] is making a systematic effort to raise production effectiveness, improve the use of productive capital and seek out and utilize the reserves for reducing production outlays. The basic directions of economic work to reduce operating expenses were determined in the integrated plan for technical development of the enterprises and intensifying economization of materials, equipment, manpower and financial resources, drawn up for 1981-1985.

The association and its enterprises are now applying expenditure norms to the entire list of fuel and energy resources, chemical reagents and the basic list of other materials. Energy outlays make up a significant share of the oil extraction expenses, which is why special attention is turned to sensible use of energy resources. Energy consumption norms are being differentiated for the leading enterprises--the main consumers of electric power, which are in turn making a similar effort in their own production units. The differential approach to distributing energy resources and establishment of technically grounded consumption norms corresponding to particular production processes encourage the collectives to systematically implement technical-economic measures to reduce losses in heating systems and power transmission lines, to achieve sensible selection of electrical equipment and energy consuming equipment and to impose more stringent norms on consumption of energy resources at every oil field facility.

As a result while the number of energy consuming facilities increased, energy outlays per well of the existing fund decreased from 7,300 rubles in 1981 to 6,600 rubles in 1983.

Each year the list of auxiliary materials to which norms are applied in relation to the most important directions of their expenditure is widening, new norms are being written, and about 1,000 norms are being reexamined, to include 800 norms applicable to materials used by the Ministry of Petroleum Industry.

While in 1982 the association had 480 approved norms in effect, in 1983 their number was increased to 900; a special Statute on Paying Bonuses for Economizing Electric and Thermal Energy, Fuel and Certain Types of Materials, Water and Other Resources was written and is now being followed by the enterprises. The resource economization activities of the enterprises are coordinated by a central commission headed by a chief engineer; the economic services are actively contributing to this effort as well.

All of this taken together is insuring thrifty use and annual reduction of consumption of the most important forms of materials (casing pipes, tubing, steel cabling, pump rods, rolled ferrous metals, drill bits, lumber, calcined soda, weighting agents and so on). In three years of the current five-year plan the outlays on materials were reduced by 15 percent and more per well.

In addition to developing and implementing technical-economic measures, the association is making an effort to increase the staffs of standardization services that are developing the norms and analyzing their fulfillment in terms of different areas of material expenditure. In order to insure a single methodological approach to technical justification of the norms, the association approved the interim methodological directives on developing norms for consumption of material-technical resources at its enterprises, and it made corrections in the procedures for analyzing their expenditure and the order of reflecting these figures in khozraschet documents at the shop and brigade level.

In addition to strengthening the standards base, steps are being taken to improve accounting of the expenditure of materials and energy using monitoring and measuring instruments. Accounting of consumption of electric power and the receipt and issue of gas and fuel oil has already been organized with the help of such instruments. These instruments account for over 60 percent of the steam and hot water that is produced and released for use. Finally, we were able to solve one of the main problems--providing the technical resources with which to account for oil and gas extraction. Accounting of oil extraction by individual shops and delivery of all commercial oil were organized. The service zones of oil extraction brigades are being equipped with brigade control units to permit separate accounting of oil extraction.

In integration with its measures to achieve economic use of fuel and energy resources, the association is also working on the problem of raising the effectiveness of technological transportation services. One of the most important measures in this area is introduction of an operation-by-operation system of organizing and evaluating the work of technological transportation and special equipment involved in overhaul and current repair of wells. Based on a controllable complex of production operations, this system, when combined with a new system for planning payments for services associated with well overhaul based on individual estimates, insures clearer mutual coordination of work between the technological transportation administration and the administration for increasing reservoir oil output and well overhaul on the basis of the end results of fulfilling their quotas. As a result labor productivity rises, cost decreases, and well repair time decreases. For example the average cost of one overhaul decreased by 3 percent and more in 1983, even though the

complexity of such overhaul increased. Introduction of the Arlanskaya system in combination with other measures stopped growth of absolute outlays on underground repairs and reduced transportation expenses per well of the existing fund by 500 rubles (or 11 percent) in the last 3 years.

The association is also making a systematic effort to achieve economization of fuel and lubricants. Each year differentiated norms for expenditure of automotive fuel are established for the enterprises, and its consumption is constantly monitored. Steps being taken in the association to reduce overtime operation of motor transportation are promoting an increase in the effectiveness with which transportation resources are being used.

But this effort is not yet sufficient: Far from all possibilities for making sensible use of transportation and for economizing on fuel and lubricants are being utilized. Economists have a great amount of meticulous work to do in this area.

A new order of economic stimulation depending on the results of satisfying the standards on material outlays, introduced in the sector, should make the collectives of the enterprises more interested in economical use of materials, fuel and energy resources. The association made timely preparations for a transition to direct deductions into the economic stimulation funds, and in 1983 it economized its material outlays by 0.5 percent, owing to which an additional 209,000 rubles were deducted into the economic stimulation funds.

In accordance with the sector's recommendations the association is already employing a system for paying bonuses for economizing on fuel and electric and thermal power, increasing compensation of reactive power and reducing surcharges to the rates for electric power. But there are many things that are still unclear in this area; the guidelines do not clearly express all information concerned with both the use of the special material incentive fund and the writing of bonus payment provisions. There are also certain difficulties in coordinating planning with standardization and with accounting of material resources in the collectives themselves when their business activities support economization and the bonus fund.

To make effective use of manpower, the association is taking steps to automate production processes, to introduce remote control, to mechanize laborious operations and manual labor, to improve labor organization, to improve the use of working time and to reinforce labor discipline. Efforts being made at the enterprises in this direction are promoting a systematic decrease in relative labor outlays and making it possible to achieve economical use of the wage fund. Thus in the last 3 years of the five-year plan the equivalent of 2,554 persons were released for other work due to introduction of a complex of measures for technical development and improvement of the economic mechanism; the resulting savings in the wage fund was 5.4 million rubles.

Brigade forms of labor organization, which are being applied to increasingly larger numbers of workers every year, and which are expanding their zones of service, are promoting a rise in the effectiveness with which resources are utilized and a decrease in operating expenses. For example in 3 years of the

current five-year plan the relative labor outlays in oil extraction dropped by 11.5 percent while average wages increased by 10.4 percent; the relative number of brigade workers involved in oil extraction decreased by 18.4 percent while the number of wells serviced by such workers increased by 26.3 percent (from 7.6 to 9.6).

There are 2,660 brigades employing 65.8 percent of the total number of workers (35,500 persons) now functioning in all of the association's enterprises. Development of brigade forms of labor organization and stimulation on the basis of the end results of work with regard for the personal contribution of each individual is one of the principal ways of raising production effectiveness in the association. Brigade forms of labor organization require expanded, integrated lower-level planning and local khozraschet as the main prerequisite of reducing operating expenses in all primary production units, including brigades. One thousand two hundred sixty-three brigades (47.5 percent of all functioning brigades) employing 46.5 percent of the total number of workers in brigades are working in oil extraction enterprises on the basis of brigade khozraschet.

In compliance with the new brigade statutes we have adopted, khozraschet has been introduced into all lower-level structural subdivisions, including brigades. In addition to planned production quotas, these brigades are given targets for operating expenses depending directly on their production activities. Each month their progress in fulfilling planned quotas and khozraschet planning indicators is summarized. Material stimulation of such collectives promotes their direct interest in sensible use of material and technical resources. This is especially noticeable in the results of the drilling brigades working on the basis of the brigade order, and in brigades of the administration for raising reservoir oil yield and well overhaul.

Participation of the association's enterprises in public reviews of utilization of production reserves and economization is playing an important role in mobilizing the labor collectives for raising production effectiveness and reducing operating expenses. Many of these enterprises are taking prizewinning places in the sector.

Development and implementation of measures to raise labor productivity 1 percent above the planned increase and to additionally reduce product cost by 0.5 percent had great significance. Practically all brigades, shops, oil fields and enterprises developed the appropriate measures and adopted higher pledges. As a result in 6 months of 1984 labor productivity was increased by 1.2 percent over the planned increment, which was equivalent to the release of 63 persons for other work; Tatneft' as a whole saved 3.9 million rubles in operating expenses.

Fulfillment of major programs of measures to achieve effective use of all forms of production resources is making it possible for the association's enterprises to reduce the level of operating expenses per well each year. In comparison with the previous period, expenses were reduced by 5 percent in 1982 and by 4.6 percent in 1983. In this case material outlays were reduced correspondingly by 10.6 and 11.7 percent, while energy outlays were decreased by 2.4 and 6.9 percent.

For efforts to improve technical-economic indicators and reduce production outlays to be successful, the association's economic services must be reinforced by qualified specialists.

If we are to mobilize the reserves for reducing material outlays, we need to expand the list of material resources for which bonuses can be paid to workers who economize on them, and we need to include all valuable materials used by oilmen in this list.

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OIL AND GAS

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PERMNEFT' FINDS WAYS TO RAISE LABOR PRODUCTIVITY

Moscow NEFTYANOYE KHOZYAYSTVO in Russian No 10, Oct 84 pp 6-7

[Article by Yu. F. Skovorodin, Permneft': "Experience in Promoting Growth of Labor Productivity"]

[Text] Fulfilling the decisions of the 26th CPSU Congress and the November (1982) and June (1983) plenums of the CPSU Central Committee, the association's collective successfully completed its counterplan, its planned quotas and its socialist pledges for 1983; in particular the labor productivity plan was 100.5 percent fulfilled in oil extraction, 106.5 percent fulfilled in drilling, 105 percent fulfilled in transportation and 105.6 percent fulfilled in geological prospecting. In 3 years of the 11th Five-Year Plan the association exceeded its oil extraction quota by 280,000 tons, its petroleum gas extraction quota by 63 million m^3 and its product sales quota by 15.7 million rubles.

As was emphasized in the December (1983) and February (1984) plenums of the CPSU Central Committee, a major increase in labor productivity is a key economic task.

The association is making a certain effort to promote growth in labor productivity beyond the planned increase.

The average annual increase in the oil well fund in 4 years of the current five-year plan was 10.3 percent; this increase occurred concurrently with only a 2.8 percent increase in the number of industrial production personnel.

As we know, in petroleum extraction the relative labor outlays per well of the operating fund are an indicator of growth in labor productivity. This is why measures to reduce relative labor outlays are drawn up each year by the association and its petroleum and gas extraction administration in support of the planned quotas for oil and gas extraction. In 1983 this plan of measures was surpassed, and the equivalent of 467 persons were released for other work, which is also equivalent to a 6.7 percent increase in labor productivity. In 3 years of the 11th Five-Year Plan the relative labor outlays of the association decreased by 18.6 percent below the 1980 level, which was equivalent to the release of 1,395 persons; in this case labor productivity increased by 13.9 percent.

In 1984 the association developed a plan of measures to reduce relative labor outlays by 7.5 percent and consequently increase labor productivity by 7.1 percent.

Let us examine the measures which promoted the decline in the association's relative labor outlays.

Scientific-technical progress and the creation, production and introduction of labor-saving equipment and processes are the principal base of growth in labor productivity. The association introduced automated control over the work of wells, making it possible to decrease the number of maintenance personnel. In 1983 343 wells were automated, which was equivalent to releasing 227 workers. Another 218 wells will be automated before the end of 1984. This will be equivalent to releasing 177 persons, and it will reduce relative labor outlays by 2.4 percent. The proportion of oil extracted from automated oil fields will be increased to 73.5 percent.

Introduction of new methods for raising the oil output of the reservoirs had great significance to raising labor productivity in the association. Additional extraction resulting from such production was 6.4 tons of oil per worker in 1983. Introduction of new equipment to mechanize the operations of current well repairs and conversion of repair brigades to the Arlanskaya system of organizing and stimulating labor increased well operating time between repairs by 7.8 percent and decreased the frequency of repairs on one well by an average of 6.8 percent and the down time of one well by 5.2 percent in 1983. The number of wells serviced by a single shift increased by 25 percent.

Conversion of the oil extraction brigades to integrated maintenance of wells and piecework wages made it possible to improve well maintenance, reduce well down time in anticipation of surface repairs and raise the well operation coefficient to 0.95.

Cross-training of brigade members has special significance to the brigade form of labor organization. This significantly reduces the size of the brigade, and consequently raises labor productivity.

In 1983 the association trained 3,500 new workers, while 1,206 were cross-trained. As of now 2,183 persons are cross-trained, with 1,097 having received training in oil extraction.

The association believes mechanization of manual operations and reduction of the number of work stations at which heavy, obsolete operations are carried out to be an extremely significant reserve for growth in labor productivity, and concurrently a means of fundamental social transformation of the content of labor itself. In this connection it drew up a specific-purpose integrated program for mechanizing manual labor. In 1983 an equivalent of 15 workers were released just due to mechanization of current well repairs.

It is extremely important to sensibly organize the daily labor of each worker, and to create good working conditions for him. Efficient, competent organization of labor is one of the most important prerequisites of raising the

effectiveness of labor. These problems are being solved by the association through scientific organization of labor, the end goal of which is to achieve economization of labor outlays in each operation, and a thrifty attitude toward every minute of working time. In 1983 the equivalent of 201 workers were released due to introduction of scientific organization of labor measures in the association's subunits, without the need for any additional construction. Plans for scientific organization of labor, standard plans for organizing work stations, norms and standards concerned with oil extraction were extended to an additional 850 persons, as a result of which an equivalent of 29 workers were freed.

Discipline, order, high organization and responsibility are the most important prerequisites of well-tuned, trouble-free operation of the entire economic mechanism. The fight against disciplinary violations is being waged persistently and consistently in the association's collectives, using the entire complex of administrative, economic and educational measures. Owing to this, losses of working time were almost halved in comparison to 1982. In this case the best results are achieved in the presence of the brigade system of labor organization. Brigades now employ 74.1 percent of the association's workers in all subdivisions of activity, to include 88.1 percent in oil extraction, 74.1 percent in drilling and 64.4 percent in transportation. Of the total number of the brigades--1,093--43.7 percent are working on the basis of the single order; of these, 68.5 percent receive wages based on the end results of their labor.

Brigades of a new type--integrated khozraschet brigades--are enjoying increasingly greater development. 35.7 percent of all brigades have been converted to brigade khozraschet. These brigades show better results than others in raising labor productivity, reducing losses of working time, economizing on material resources and asserting a spirit of real collectivism, mutual exactingness and comradely mutual assistance.

Pledges to exceed the labor productivity plan by 1 percent and reduce product cost by an additional 0.5 percent were adopted for 1984.

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OIL AND GAS

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ECONOMIC EFFECTIVENESS ASSESSMENT PROCEDURE IMPROVED

Moscow NEFTYANOYE KHOZYAYSTVO in Russian No 10, Oct 84 pp 11-15

[Article by O. L. Kuznetsova, Moscow Institute of Petrochemical and Gas Industry imeni I. M. Gubkin: "Economic Effectiveness of Methods to Outfit Oil and Gas Fields in Extreme Conditions of the North"]

[Text] The effectiveness of measures to create and develop new oil and gas extracting enterprises using the modular outfitting method is practically impossible to estimate by the traditional methods of determining the effectiveness of new equipment or capital investments. Most of them are typified not by a systemic, national economic approach to evaluating effectiveness, but rather by a local, sector approach.

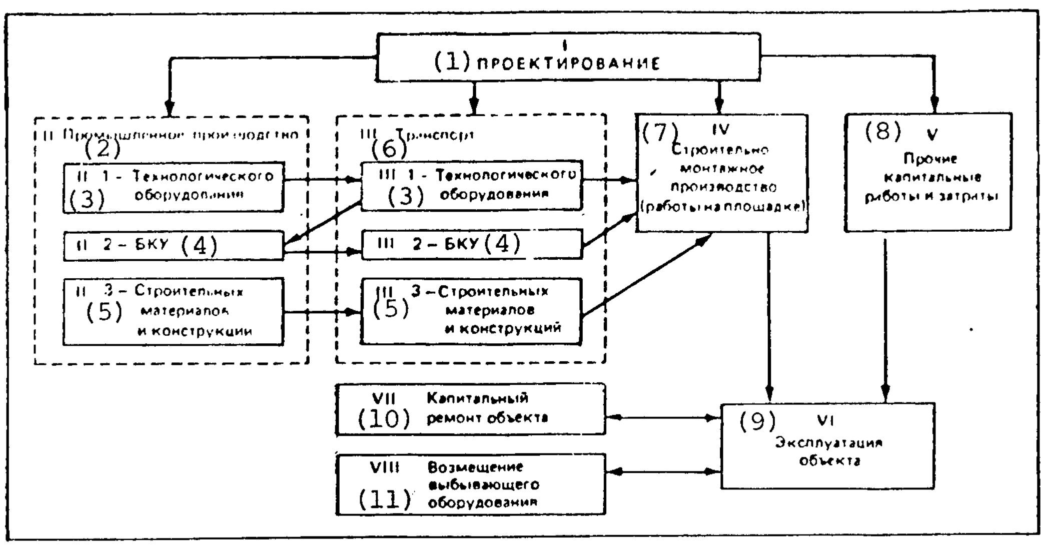
Comparison with the annual economic impact calculated on the basis of existing sector instructions for determining the effectiveness of new equipment in petroleum industry would reveal methodological differences in both approaches and significant discrepancies in the evaluation of the effectiveness of similar measures from the positions of different departments. Also, many factors are not accounted for when the effectiveness of the development of oil and gas field facilities is calculated using the standard procedures for determining economic effectiveness of capital investments, in accordance with which the goal (the effectiveness of social production) is reduced to a particular task--optimum utilization of a resource--and only one at that.

All of the procedures do not take full account of social factors, and primarily the one-time and current outlays on facilities of the social infrastructure, as well as the social consequences of intensification. As a rule the objects of evaluation are individual structures, and not the entire complex or system of supporting facilities in general. There is no clear differentiation between the principal stages and participants of the production-investment process, and differences in the times that outlays are made and useful results are attained are not accounted for. All of this leads to inaccuracies in determining certain elements of the outlays in the comparisons made between them and the achieved end results, and it causes errors in calculating economic effectiveness.

An improved procedure proposed here for determining the economic effectiveness of creating the production, social and personal infrastructure of new oil and

gas extracting enterprises makes it possible to evaluate the relative and overall effectiveness of construction methods on the basis of indicators of the integral discounted reduced and relative outlays; to account for the influence of differences in the times that outlays are made and useful results are obtained, and in the times it takes to build and service the facilities; to reflect, in the magnitude of the impact, the effect of socioeconomic factors, and to establish the economic impact generated by individual participants of the production-investment process.

Development of the material-technical base of oil and gas field administration may be represented as a single production-investment process including eight spheres pertaining to the five principal participants of this process: the planner, the manufacturer of equipment and modular installations, the transporter, the contractor assembling the modular installations, and the client who operates the facility and keeps it under repair (see figure). In this case it is especially important to correctly distribute the overall economic impact between the individual spheres and participants of this process. We will view the effectiveness of the modular construction method as an inherent element of the intensive path of developing the material-technical base of oil and gas field administration.



Division of Outlays to Develop Oil and Gas Fields
in West Siberia Among Different Spheres

Key:

1. Planning
2. Industrial production
3. Production equipment
4. Modular installations
5. Construction materials and structures
6. Transportation
7. Construction and installation (work at the construction site)
8. Other capital operations and outlays
9. Operation of the facility
10. Overhaul of the facility
11. Compensation for removed equipment

We will calculate effectiveness in application to the full complex of outfitting facilities involved in the collection, transportation and treatment of oil or gas for subsequent transfer to a main pipeline, and in relation to the entire period of exploitation of the deposit, with regard for differences in the times that outlays are made and results are obtained; moreover these outlays will be adjusted to the prices of the base year.

We will use a system of indicators for relative and general effectiveness to evaluate the economic effectiveness of the new methods of developing the material-technical base of oil and gas field administration. The indicators of overall effectiveness characterize the relationship between outlays and useful results in regard to the use of a particular method for developing the base, while indicators of relative effectiveness characterize the improvement made in this relationship by introduction of a new method in comparison with the base (traditional) method.

The overall effectiveness of the new and the base methods for developing the material-technical base is characterized by relative outlays (correspondingly $z_{\text{н}}, z_{\text{б}}$) and the reciprocal indicator (correspondingly $y_{\text{н}}, y_{\text{б}}$)--the volume of commercial oil or gas produced per ruble of outlays. These indicators are defined by the formulas

$$z_{\text{н}} = \frac{з_{\Sigma \text{н}}}{p_{\Sigma \text{н}}}, \quad z_{\text{б}} = \frac{з_{\Sigma \text{б}}}{p_{\Sigma \text{б}}}, \qquad (1)$$

$$y_{\text{н}} = \frac{p_{\Sigma \text{н}}}{з_{\Sigma \text{н}}}, \quad y_{\text{б}} = \frac{p_{\Sigma \text{б}}}{з_{\Sigma \text{б}}}, \qquad (2)$$

where $з_{\Sigma \text{н}}, p_{\Sigma \text{н}}$ --correspondingly the integral discounted reduced outlays (millions of rubles) and useful results (volume of commercial oil or gas produced, million tons or billion m^3), associated with the creation and function of the complex of supporting facilities, using the new method; $з_{\Sigma \text{б}}, p_{\Sigma \text{б}}$ --the same, using the base method.

The principal indicators of relative effectiveness are the savings of relative outlays Δz, defined as the difference in relative outlays determined by the base method z_6 and the new method z_H (rubles per ton of oil or rubles per 1,000 m^3 of gas), and the integral economic impact (millions of rubles) calculated using the formula

$$э = \Delta z p_{\Sigma} = з_{\Sigma \text{б}} - з_{\Sigma \text{н}}. \qquad (3)$$

If the useful results of operating the complex are different for the two methods, the expression $з_{\Sigma \text{б}} p_{\Sigma \text{н}} / p_{\Sigma \text{б}}$ is substituted for $з_{\Sigma \text{б}}$ in formula (3).

The reduced outlays in the spheres of industrial production, transportation and construction are determined with regard for current and one-time outlays on facilities of the social infrastructure using the formula

$$з_i = c_i + c_{i\text{сн}} + E_{\text{н}}(\Phi_i + \Phi_{i\text{сн}}), \qquad (4)$$

where $з_i$--reduced outlays in sphere i; c_i--cost of operations in sphere i; $c_{i\text{сн}}$--additional current outlays on facilities of the social infrastructure necessary for completion of operations in sphere i; E_H--standard effectiveness

coefficient, Φ_i, $\Phi_{i\,сн}$ --mean annual cost of fixed productive capital in sphere i and capital of the social infrastructure respectively.

Operations may be performed in sphere II.2 (manufacture of modular installations) by enterprises of machine building ministries (the Ministry of Chemical and Petroleum Machine Building, Ministry of Shipbuilding Industry etc.), by plants of the Ministry Petroleum Industry and the Ministry of Gas Industry, and by enterprises of construction ministries (Ministry of Construction of Petroleum and Gas Industry Enterprises etc.). Operations are performed in spheres V, VI and VIII by organizations of the Ministry of Petroleum and the Ministry of Gas Industry, while operations in sphere VII are carried out by operating organizations and by construction and repair organizations.

The calculation procedure does not depend on the ministry or department in which the operations are carried out; it is affected only by the outlays required to complete these operations. When operations are distributed differently among ministries and departments, the outlays on each operation would also turn out to be different, but it is not within our objective to compare such variants of work organization. We will assume here that modular installations are manufactured and delivered to the assembly site, together with the production equipment installed in them, in fully prefabricated form and ready for operation. To calculate the outlays on transportation of equipment delivered in the modular variant, these outlays are divided between spheres III.1 and III.2. Outlays on delivering equipment to the plant manufacturing the modular installations are accounted for in sphere III.1, and part of the outlays for delivering the modular installations to the installation site (the outlays of installing equipment into a modular box or a modular container) are accounted for in sphere III.2. In the traditional variant, outlays on transportation of the equipment cover delivery of this equipment to the construction site.

Inasmuch as the cost of operations (products) is accounted for in the outlays of each sphere, we can reflect the differences in profitability of the traditional and modular outfitting methods.

Outlays in the operation sphere should be calculated using a formula accounting for all elements of operating expenses, as well as additional capital investments and current outlays on the social infrastructure:

$$s_{э} = c_{з.п} + c_{м} + c_{с.п} + c_{пр} + c_{с.и} + E_{н}\,\Phi_{с.и}, \qquad (5)$$

where $c_{зп}$--wages (basic and supplementary) of operational and repair personnel; $c_{М}$--outlays on fuel, energy and auxiliary materials; $c_{сп}$--outlays on maintenance, operation and current repair of equipment and production areas (not counting depreciation); $c_{пр}$--other current outlays on operation of the facility, including general oil field outlays; $c_{с.и}$, $\Phi_{с.и}$ --correspondingly the additional current outlays and the mean annual cost of fixed capital, stated in relation to individual facilities of the social infrastructure, necessary for normal operation of the facility.

Inasmuch as one-time outlays on erection of a facility are already accounted for among the outlays in spheres I-V, neither depreciation of the fixed capital of the facility nor its standard effectiveness should be accounted for in the outlays of the operation sphere. Nor should we account for outlays on overhaul of the facility, which are accounted for in sphere VII, or outlays to compensate removed fixed capital, which are accounted for in sphere VIII. Thus in our calculations we determine the "net current operating expenses" $3_{э}$.

The possibility for not only calculating the integral economic impact from intensive development of the material-technical base of oil field administration but also for distributing it among individual spheres and participants of the production-investment process is a distinguishing feature of the proposed procedure. The total outlays in each sphere do not include the outlays of preceding spheres, and therefore they give a sufficiently precise reflection of the "efforts" applied in the given sphere to achieve the single useful result. This makes it possible to distribute the total national economic impact among the spheres in proportion to their reduced outlays.

Differentiation of this impact, which manifests itself as a decrease in the total outlays of live and materialized labor per unit of end product (oil or gas), is especially important because it allows us to account for the impact from increasing the fuel extraction volumes and economizing on resources. The latter is achieved as a result of reduction of the time it takes to outfit an oil field, a decrease in the volume of construction work at the site, an increase in the quality of assembly operations, unification and standardization of facilities, an increase in the unit output capacity of machine units, use of more-compact equipment and improvements of the conditions for operation and repair services.

The proposed procedure was used to calculate the economic effectiveness of two schemes for outfitting the first and second generations of the Samotlor oil deposit.

The first scheme foresaw extraction of low water content oil, while the second foresaw extraction of oil requiring deeper treatment. Calculations were made for a reservoir pressure maintenance system consisting of two group pumping stations and oil collecting and transporting systems including three booster pumping stations in the first scheme and an oil treatment facility and boiler shop in the second. Two variants were calculated--a base variant (corresponding to the tradition method) and a new variant (foreseeing complete or partial modular execution of the facilities).

Only the indicators of relative effectiveness--that is, the integral economic impact in absolute terms, related to expenditures of all or individual production resources--are determined for individual facilities (or their complexes) which are involved in intermediate production (Table 1).

As is evident from Table 1, use of the modular outfitting method reduces total outlays by 3-7 percent. In this case the impact averages 15-20 percent of the capital investments on erection of the facilities. The obtained indicators

Table 1

(1) Объект (комплекс объектов)	Интегральный экономический эффект (2)			
	(3) тыс. руб.	% относительно (4)		
		(5) затрат в базисном варианте	(6) капиталовложений в базисном варианте	(7) стоимости БКУ
(8) Система:				
(9) ППД	1344	3,2	18,1	90
(10) сбора и транспорта нефти (первая схема обустройства)	3516	6,9	14,0	98
(11) Установка подготовки нефти	950	5,5	25,9	234
(12) Котельная	188	5,4	50,7	103
(13) Система сбора и транспорта нефти (вторая схема обустройства)	1883	5,0	20,1	202

Key:

1. Facility (complex of facilities)
2. Integral economic impact
3. Thousands of rubles
4. Percent relative to
5. Outlays in the base variant
6. Capital investments in the base variant
7. Cost of modular facilities
8. System
9. Reservoir pressure maintenance
10. Oil collection and transportation (first outfitting scheme)
11. Oil treatment facility
12. Boiler shop
13. Oil collection and transportation system (second outfitting scheme)

Table 2

Spheres of Production-Investment Process	Outfitting Scheme: First	Outfitting Scheme: Second
Total economic impact, percent	100.0	100.0
Including, broken down into spheres:		
I. Planning	0.9	0.6
II. Industrial production, total	7.5	12.5
Including:		
II.1--Equipment	4.6	11.0
II.2--Modular facilities	2.6	1.3
II.3--Construction materials and structures	0.3	0.2
III. Transportation of equipment, modular facilities, construction materials	1.0	0.6
IV. Construction and installation operations at the site	24.1	7.4
V-VI. Other capital operations and outlays, operation of facilities	60.5	75.0
VII-VIII. Overhaul and compensation for removed euqipment	6.0	3.9

are sufficiently high, but they are lower than those usually published. This is associated with several factors. Reduction of the time it takes to erect individual facilities in the modular execution does not automatically result in the same reduction of the time it takes to outfit the complex. The proportion of modular facilities in the oil field collection and transportation system is small, and the resulting savings is negligible in comparison with the total cost of the system.

The effectiveness of the method is reduced in many ways owing to the negative influence of the modular execution upon some operational indicators, and primarily the outlays on maintaining, operating and repairing the equipment. This is associated with the fact that not enough attention is devoted in the planning of modular facilities to reducing the number of operating personnel, though the method does provide significant possibilities for automating production processes.

The integral economic impact calculated by the proposed procedure is distributed among the spheres of the production-investment process in accordance with Table 2.

The largest share of the impact is assigned to operations performed by the client: operation, other capital operations and outlays. Construction organizations doing work at the site are credited with 7-24 percent of the impact. The share of the impact in the transportation and planning spheres does not exceed 1 percent, even though introduction of the new methods depends to a significant degree on planners. A significant share of the impact (4-6 percent) is awarded to spheres of capital repair and compensation for removed equipment. These operations are performed by the operating organization, for example by the repair section of the petroleum and gas extraction administration. To raise the effectiveness of repair services, it would be suitable to assign them to a subcontractor who would make service calls as required.

This improved procedure for determining the economic effectiveness of new methods of creating the material-technical base of oil and gas field administration in the North may be used to determine the technical-economic grounds of master plans for development of oil and gas industry, and to determine the basic directions of economic and social development of these sectors in the future. Enterprises of petroleum and gas industry may also employ this procedure to plan their own work and to monitor implementation of integrated specific-purpose scientific-production programs for development of the modular construction method.

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OIL AND GAS

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EXPERIMENT CONDUCTED WITH WET IN SITU COMBUSTION

Moscow NEFTYANOYE KHOZYAYSTVO in Russian No 10, Oct 84 pp 30-34

[Article by R. T. Fazlyyev, K. I. Verevkin, R. N. Diyashev and M. M. Musin, TatNIPIneft' /Tatar State Scientific-Research and Design Institute for the Oil Industry/, and I. A. Tkachenko, Al'met'yevneft' Petroleum and Gas Extraction Administration: "Results of Introducing In-Situ Combustion at Pool No 24 of the Romashkinskoye Deposit"]

[Text] The principal oil deposits of the Tatar ASSR, which are confined to terrigenic Devonian reservoirs, are in a late stage of development. The rate of decline of oil extraction may be reduced by initiating development of reserves of hard-to-extract hydrocarbons--heavy oils and natural bitumens in Permian deposits as well as high-viscosity oils from terrigenic and carbonate Carboniferous deposits. If we are to work them with sufficiently high technical-economic indicators, we must create and improve methods for raising the oil output of the beds, which includes wet in situ combustion.

Wet in situ combustion has been undergoing testing in pool No 24 of the Bobrikovskiy horizon of the Romashkinskoye deposit since 1979 with the objective of intensifying the rate of oil extraction and increasing the final oil output of the beds. Plans have been made for experimental industrial testing of wet in situ combustion at the Arkhangelskoye, Nurlatskoye and Vishnevo-Polyanskoye deposits of the Tatar ASSR. Use of wet in situ combustion is planned at these deposits as a means of primary stimulation of the productive bed.

Let us examine the results of introducing wet in situ combustion to pool No 24, a diagram of which is shown in Figure 1, and let us evaluate its technological impact. The Trix-Liz deposit in the USA was selected for comparison as a control [1]. The basic geological and physical characteristics of these locations are given in Table 1.

In terms of the production system, pool No 24 should be developed by two methods: using wet in situ combustion followed by displacement of the hot fringe by cold water in the northwestern part (west of wells No 13, 14; see Figure 1), and perimeter flooding in the southeastern part. Creation of nine combustion sites was proposed--three in 1978 and two each year in 1979-1981. The calculated duration of the wet combustion phase in each element is 3.5 years; the total volume of injected air is 44.0 million m^3, and the maximum

injection rate is 40,000 m^3/day for 2.5 years (the volumes of air and gas are adjusted to normal conditions). Injection of cold water into the burnt-out zone was foreseen at a volume of 80-100 m^3/day until 95 percent water encroachment of the wells. The production indicators for wet in situ combustion were calculated assuming equality of the concentration of residual fuel (17 kg/m^3), the oxygen utilization factor (0.85) and the water-air factor (0.002). In situ combustion was to increase the final oil output of the pool by 10 percent in comparison with the oil output resulting from flooding.

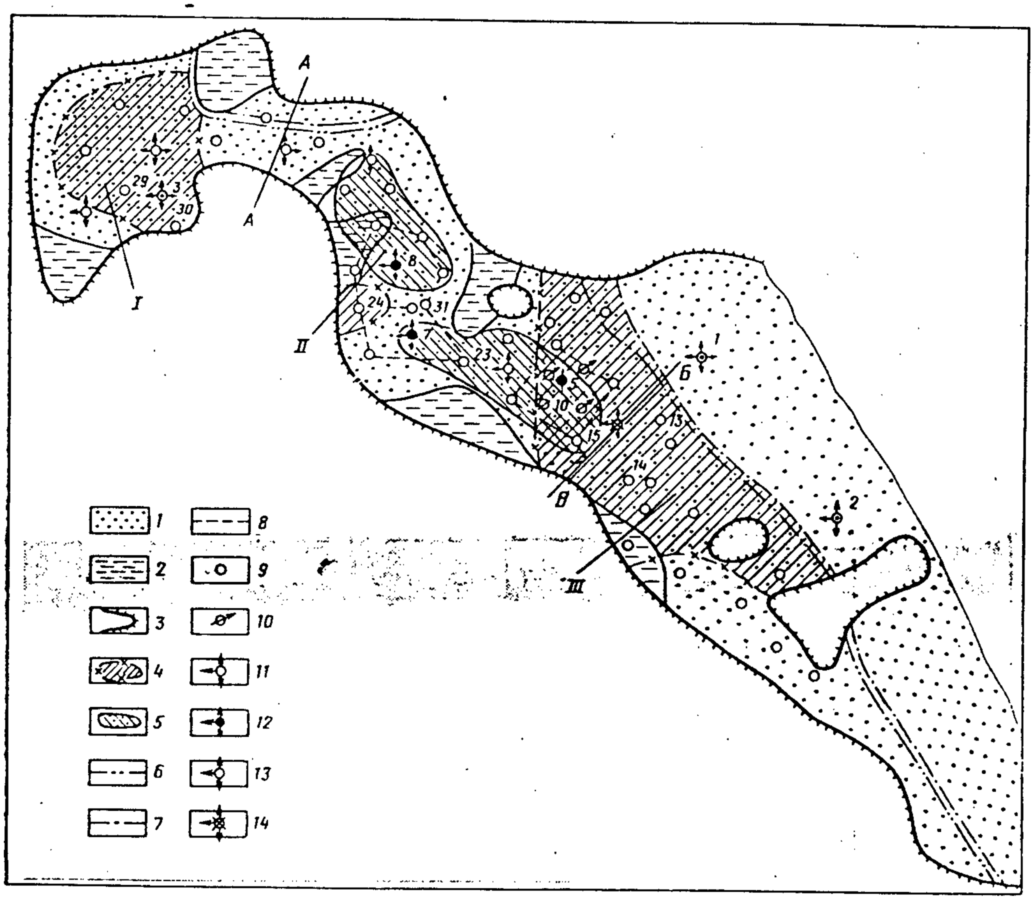

Figure 1. Diagram of Pool No 24: *A*, *B*--Zone boundaries; *I*, *II*, *III*--zones worked by different methods; *1*--sandstone; *2*--aleurolite; *3*--pinching-out zones; *4*--zones flooded by 1 January 1984; *5*--zones within reach of combustion gases; *6*,*7*--correspondingly the inner and outer water-oil boundary lines; *8*--boundaries of the components of in situ combustion wells. Wells: *9*--producing, *10*--monitoring-producing, *11*--water injection, *12*--ignition (operating, planned), *13*--abandoned

Table 1

Parameter	Pool No 24, Romashkinskoye Deposit	Trix-Liz Deposit
Producing formation	Sand formation B_{II}, Bobrikovskiy horizon	Woodbane sandstone
Characteristics of producing formation:		
Depth, m	1,000	1,100
Thickness, m	3.16	2.77
Porosity, percent	24.00	28.00
Permeability, μ^2	0.69	0.50
Sand factor	0.83	0.64
Initial pressure, MPa	10.90	13.60
Temperature, °C	20	59
Initial oil saturation	0.83	0.65
Characteristics of formation oil:		
Density, gm/cm^3	0.87	0.91
Viscosity, mPa•sec	20.40	26.00
Gas factor, m^3/ton	16.50	13.40
Saturation pressure, MPa	5.50	-

Development of the pool began in early 1978 under natural flow with the purpose of reducing reservoir pressure to 7.0-7.5 MPa. Because construction of a compressor station to maintain the necessary reservoir pressure fell behind, injection of water into perimeter well No 1 at a mouth pressure of 16-17 MPa was organized. This insured a high rate of advance of the displacement front and an increase in the reservoir pressure difference to 6-7 MPa within the limits of one component.

The first site of combustion was created in March 1979 in the vicinity of well No 5 by introducing about 4.5 million kJ of heat into the formation by an electric heater in the vicinity of well No 5. Direct signs of in situ combustion were noted: The gaseous products of the neighboring well No 11 contained up to 8 percent carbon dioxide, 1.5 percent carbon monoxide and up to 5 percent oxygen. During the combustion stabilization period, however, a breakthrough of combustion gases occurred as far as well No 31, and the air injection pressure decreased from 11.0 to 5.5 MPa. In this connection the injection rate was sharply increased, which caused spouting of the reacting wells No 11, 23 and 31 through the subsurface pump. After conversion to free-flow exploitation they were squeezed off by saline water, but owing to reservoir energy they could not be started up, and in the future they were left inactive. This altered the direction of the filtrational and heat flows, which reduced the oxygen utilization factor of injected air, the injection of which was halted in September 1979.

In 1979-1980 large volumes of water were injected into wells No 1 and 2. This extended the displacement front as far as well No 11.

Development of the pool's northwestern section was begun in late 1979. It was isolated as an independent production entity as pool No 6. The plan for development foresaw water flooding at a mouth pressure of 8-10 MPa. In reality, however, water was injected into well No 3 at a mouth pressure of about 17.0 MPa, which caused hydraulic fracturing of the formation as far as wells No 29 and 30 and fast flooding of the wells within the zone.

In February 1981 combustion was initiated a second time in well No 5 after a significant part of the formation had been flooded within the limits of the pool component. The air injection volume was increased by 50 m^3/hr every 6 days, and by June 1981 it attained 34,000 m^3/day at an average injection pressure of 7.0 MPa. Prior to July the process went on in accordance with the production plan, and subsequently the oxygen utilization factor was lower than planned. This was the result of basically the same causes encountered in 1979--that is, inactivity of reacting wells. Their return to regular operation beginning in February 1982 and a decrease in the air injection volume normalized in situ combustion. The spread of combustion gases through the formation by 1 January 1982 is shown in Figure 1. Reservoir temperature recorded in well No 11 was 22° higher than the initial temperature. In September 1982 air injection into well No 5 was halted because of trouble in the well.

The second combustion site was created in January 1981 in well No 8. Combustion gases spread northward due to high reservoir pressure in the vicinity of well No 24 generated as a result of injection of water into well No 3. The daily air injection volume was increased at the same rate as with well No 5, while injection pressure at maximum flow was 10.5 MPa. Growth in the concentration of oxygen in the gaseous products and its breakthrough into wells located outside this pool component were observed beginning in July 1981. Attempts to achieve a transition from dry to wet combustion (780 m^3 of water were injected into well No 8) were not followed through, because some specialists made it known that reduction of the concentration of residual fuel was possible. Beginning in November 1981 the reacting wells were operated irregularly. The concentration of oxygen in their products did not decrease, and in June 1982 air injection was ceased.

Wet in situ combustion was controlled by monitoring the composition of extracted gases and fluids and the reservoir temperature in observation wells with respect to time. Over 1,500 samples of gases from 25 wells were analyzed, making it possible to reveal the direction of combustion gas filtration through the reservoir and the time of their breakthrough into the wells. The oxygen utilization factor averaged 0.77 in 1981-1982. A tendency for viscosity and density of the oil to grow was observed in actively reacting wells.

The main causes which made wet in situ combustion complex and reduced the oxygen utilization factor of injected air in comparison with the planned factor were:

deviation of actual development indicators from planned indicators, taking the form of early flooding that led to creation of a large pressure difference within the limits of a single combustion site;

the need for fulfilling the plans for injecting air into the reservoir, which necessitated faster increase in injection volume during the period of stabilization of the combustion process;

shut-down of reacting wells, which sharply altered the direction of filtrational and heat flows and caused injected air to bypass the high temperature zones;

late initiation of the wet combustion phase.

Because of the complications encountered in in situ combustion, some researchers suggested that the concentration of residual fuel q in pool No 24 was insufficient [2]. Therefore this indicator was evaluated on the basis of data from laboratory experiments, correlation formulas and oil field experiments carried out in conditions close to those of the pool.

A tubular model of the reservoir 110 cm long filled with quartz sand with a permeability of 3.6 μ^2 and with saturated degassed oil from pool No 24 was used in the laboratory experiment. It was established that wet in situ combustion proceeds successfully, and the mean value of q is equal to 12.5 kg/m^3 at a water-air factor of 0.0013.

The temperature profiles of the process, during which the front of combustion advanced along the model of the reservoir, are given in Figure 2. They show that after transition to wet in situ combustion (see Figure, curve *5*), a vapor plateau forms before the combustion front, and favorable conditions for combustion are created in terms of terms of temperature and residual fuel both within the limits of this plateau. According to laboratory data about 17 percent of the oil is extracted from the zone affected only by air, and on the whole a displacement factor of 0.9 is attained with wet in situ combustion.

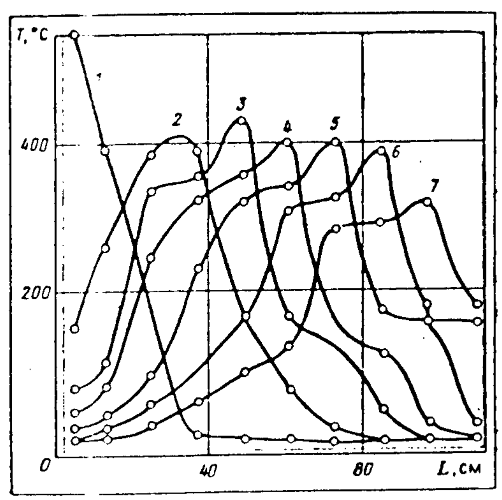

Figure 2. Temperature T Distribution Profiles in Relation to the Length of the Reservoir Model L at Different Moments of Measurement (*1*-*7*)

It follows from correlation formulas published by the VNIIOENG [not further identified] [3] and by the TatNIPIneft' and Chu [4], which were derived from laboratory and oil field research data, that q varies from 13.3 to 21.4 kg/m^3. The concentration of fuel in the Trix Liz deposit is estimated within the same limits (16 kg/m^3).

Thus the fuel concentration in pool No 24 is quite sufficient for successful conduct of wet in situ combustion.

A third combustion site was created in April-May 1983 within the bottom-hole zone of well No 7. The temperature of injected air did not exceed 115°C during the period of combustion initiation here, and low temperature oxidation apparently occurred in the reservoir. Later on signs of high temperature combustion appeared (the concentration of carbon monoxide in the gaseous products of reacting wells was 0.9-1.7 percent).

Wet in situ combustion was initiated in August 1983. On 1 March 1984 2.8 million m^3 of air and 1,800 m^3 of water were injected into well No 7. The oxygen utilization factor now corresponds to the planned value. In November-December 1983 combustion was reinitiated with the introduction of a calculated quantity of heat into well No 8. The process is presently undergoing stabilization.

Table 2

(1) № участка	(2) Метод воздействия	(3) Показатели	(4) Годы разработки (5) До 1978	1978	1979	1980	1981	1982	1983	1978—1983
I	(6) Очаговое заводнение	(7) Добыча нефти, тыс. т	—	—	1,3	29,9	36,7	43,1	28,3	139,3
		(8) Отбор жидкости, тыс. т	—	—	1,3	42,6	59,0	75,5	52,5	230,9
		(9) Закачка воды, тыс. м³	—	—	—	40,6	38,5	75,6	14,3	169,0
II	(10) ВВГ	(7) Добыча нефти, тыс. т	15,5	122,4	104,8	89,3	78,5	62,2	53,7	526,4
		(8) Отбор жидкости, тыс. т	15,5	124,1	129,0	109,5	115,7	107,4	102,7	703,9
		(11) Закачка воздуха (воды), млн. м³ (тыс. м³)	—	—	5,5	0,4	13,5 (0,8)	2,8	2,3 (0,6)	24,5 (1,4)
III	(12) Законтурное заводнение	(7) Добыча нефти, тыс. т	—	34,7	27,5	31,7	35,7	21,0	19,3	169,9
		(8) Отбор жидкости, тыс. т	—	40,6	83,2	123,9	141,1	76,6	53,9	519,3
		(9) Закачка воды, тыс. м³	—	102,3	316,8	437,6	249,5	90,6	26,8	1223,6
	(13) Всего по залежи	(7) Добыча нефти, тыс. т	15,5	157,1	133,6	150,9	150,9	126,3	101,3	835,6
		(8) Отбор жидкости, тыс. т	15,5	164,7	213,5	276,0	315,8	259,5	209,1	1454,1
		(9) Закачка воды, тыс. м³	—	102,3	316,8	478,2	288,0	166,2	41,1	1392,6
		(11) Закачка воздуха (воды), млн. м³ (тыс. м³)	—	—	5,5	0,4	13,5 (0,8)	2,8	2,3 (0,6)	24,5 (1,4)

Key:

1. Zone
2. Stimulation method
3. Indicators
4. Years of development
5. Prior to 1978
6. Water flooding
7. Oil extraction, thousands of tons
8. Fluid withdrawal, thousands of tons
9. Water injection, thousands of m^3
10. Wet in situ combustion
11. Air (water) injection, millions of m^3 (thousands of m^3)
12. Perimeter flooding
13. Total for the pool

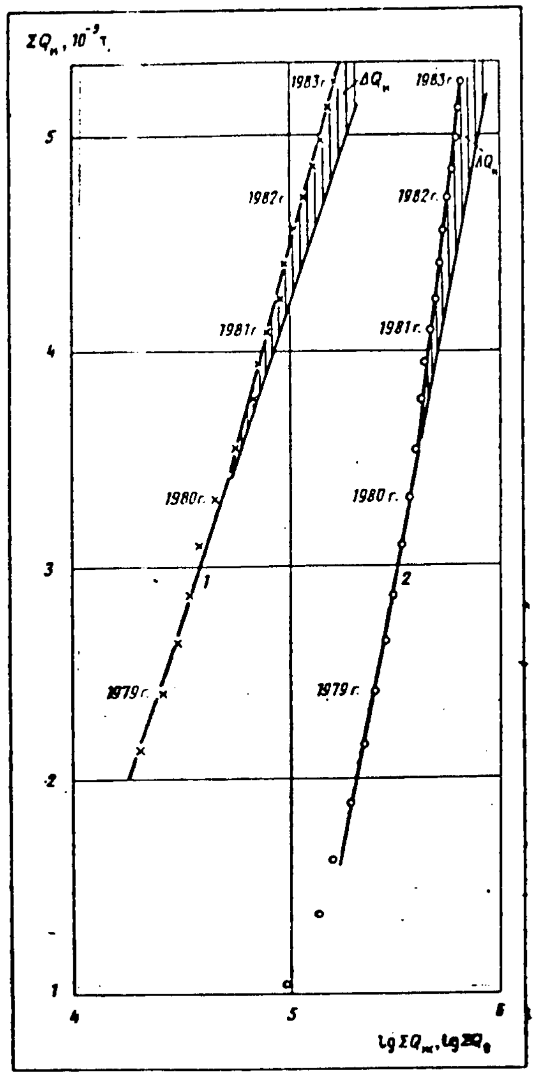

Figure 3. Characteristics of Oil Displacement from the Zone of Wet In Situ Combustion: $1 - \Sigma Q_{\text{н}} = f\,(\lg \Sigma Q_{\text{в}})$; $2 - \Sigma Q_{\text{н}} = f\,(\lg \Sigma Q_{\text{ж}})$; $\Sigma Q_{\text{н}}$, $\Sigma Q_{\text{в}}$, $\Sigma Q_{\text{ж}}$ – total extraction of oil, water and fluid respectively

The indicators for development of the pool as a whole and its individual zones, indicated in Figure 1, are presented in Table 2. It is evident from them that in the zone subjected to wet in situ combustion, oil was extracted with less water from the reservoir in comparison with other zones. Moreover the greatest oil recovery was achieved, which can be explained by peculiarities of this zone's geological structure and the hydrodynamic conditions of its development. Because development of individual zones was initiated at different times and because of the imbalance between injection and recovery, oil and water cross-flow occurred between zones (especially prior to 1981). A decrease in the volume of water injected into the perimeter area in 1981-1983 and injection of air halted the advance of water through the reservoir, as a result of which only well No 10 was flooded.

The quantity of oil extracted in 1981-1983 owing to wet in situ combustion was estimated from the volume of the reservoir affected by the process. It can be determined from the volume of oil displaced from the burnt-out zone and the vapor zone, and the quantity of oil extracted from the zone of filtration of gaseous combustion products at the initial reservoir temperature. Given an average oxygen utilization factor of 0.77 and an air injection volume of 18.6 million m^3, the volumes of the burnt-out zone and the vapor zone were 75,600 and 15,100 m^3 respectively, while the quantity of displaced oil was 10,800 and 1,900 tons respectively. Combustion gases were contained in the products of 15 wells exploiting a reservoir with a volume of 3.6 million m^3, while the quantity of oil extracted was 16,200 tons. Thus the total quantity of oil was 28,900 tons.

This developmental indicator determined for comparison by the procedures suggested by M. I. Maksimov and B. F. Sazonov was 34,000-48,000 tons (Figure 3). Subsequent research was based on data acquired by calculation.

The results of introducing wet in situ combustion to pool No 24 and the Trix Liz deposit, which was subjected to dry combustion, recognized to be technologically and economically successful [4], are as follows:

	Pool No 24, Romashkinskoye Deposit	Trix Liz Deposit
Production method prior to wet in situ combustion	Flooding	Dissolved gas
Oil saturation of the reservoir in zones of in situ combustion	0.81	0.56
Air injection volume, million m^3	18.6	51.4
Quantity of extracted oil, thousands of tons	28.9	40.6
Air-oil factor, m^3/ton	590	1,150
Oxygen utilization factor,%	77	98
Characteristics of compressor facility:		
Type	OVG-3	-
Delivery, thousands of m^3/day	103	64+28
Pressure at pump outlet, MPa	22.0	8.4

The significant decline that occurred in the air-oil factor of pool No 24 can be explained by introduction of wet in situ combustion as the primary method of stimulating a reservoir having a high oil saturation. This resulted in frontal displacement of oil by combustion gases in the initial stage of the process, it excluded outlays of energy to move water ahead of the combustion front, and it created the possibility for formation of a stable emulsion.

With wet in situ combustion, the principal outlays are associated with injecting air into the reservoir, and selection of optimum equipment cheapens the process. An experimental model of the OVG-3 compressor facility was installed at pool No 24. It underwent departmental trials, and it demonstrated good working reliability. But the results of oil field experiments showed that the pressure of air injected into formation B_{II} does not exceed 11 MPa. Therefore from an energy standpoint it would be more suitable to install compressors with an outlet pressure of about 15.0 MPa at such sites; this is also confirmed by the performance of equipment at the deposit serving as the control.

Conclusions

1. Introduction of wet in situ combustion requires executors to comply more strictly with the production plan for development.

2. The concentration of residual fuel in formation B_{II} of pool No 24 in the Romashkinskoye deposit is fully sufficient for this process.

3. The quantity of oil extracted in 1981-1983 as the result of wet in situ combustion is 28,900 tons.

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OIL AND GAS

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GAS SHOWS: POSSIBLE CLUES TO PRESENCE OF ORES

Baku IZVESTIYA AKADEMII NAUK AZERBAYDZHANSKOY SSR: SERIYA NAUK O ZEMLE in Russian No 2, 1984 pp 15-20

[Article by F. G. Dadashev, A. M. Dadashev and Yu. B. Galant: "The Natural Gases of the Southern Slope of the Greater Caucasus in Connection with Prospecting and Exploration of Sulfide Fields"]

[Text] Studies of the chemical composition and content of natural gases will enable the most diverse questions of a theoretical and applied nature to be solved. Study of the natural gases of sediments of the Greater Caucasus's southern slope is now an urgent task. This is associated first, with prospecting for fields of minerals on the Greater Caucasus's southern slope and, second, with insuring the safe performance of future operations of fields already discovered.

The need to use the gas-geochemical method for prospecting for fields is dictated by the discovery of concealed fields that have not emerged on the ancient surface, since the gas method, thanks to the high migrational property of the gases, is a deep method.

Gas-survey operations are founded on a theoretical base that is made up of a number of questions, which include:

1. The region's gas background.
2. The specific composition of the natural gases of ore fields.
3. The source of generation of the gases.
4. The paths of the gases' migration.

The gas background of the eastern terminus of the Greater Caucasus's southern slope, as a study of the chemical composition of the natural-gas shows indicates, is nitrogenous. The nitrogen content of the gases in the natural gas shows exceeds 90 percent.

In order to study the natural gases distributed at ore fields, the gas of the Filizchay and Katsdag polymetal pyrite fields was studied. A study of the gas's composition has indicated that increased amounts of carbon dioxide are present in the polymetal-pyrite fields' gases.

An increase in carbon-dioxide concentration in an area where an ore deposit is distributed allows it to be said that the increased amounts of carbon dioxide and the ore deposit are genetically related to each other.

The presence of ruptures, cleavage and fractures in the southern slope's enclosing sediments is a favorable factor for the migration of natural gases. In migrating, the gas creates an anomalous carbon-dioxide environment, which is recorded during the conduct of gas-geochemical surveys.

The gas-geochemical survey was performed at the Tenros-Chugak, Katsmala, Karabchay and Agdamkelal sections.

The Tenros-Chugak section is interesting because oxidized and thermally altered zones have been observed here. The Katsmala section is of interest because of the possible continuation therein of the Katsmala and Kekhnamedan ore-bearing zones.

The Karabchay section is of interest because of the possible continuation of the Filizchay field's deposit to the south.

The Agdamkelal section is of interest because anomalies have been obtained here: a natural electromagnetic field of high intensity--up to 400 mV--and an apparent polarizability with an intensity of up to 20 percent against a background of 5 percent.

At the Tenros-Chugak section, 15 gas profiles were performed. The carbon-dioxide concentration in the subsoil air reached 3.3 percent. Nine anomalous zones with a contrast coefficient of more than 2 were also identified in various parts of the cross-section. The anomalies with the most contrast form a northeast-southwest belt, that is, a fracture of the Anticaucasus trend is possibly recorded and the ore-bearing zones are usually confined to the places where the anomalies intersect with fractures of the Caucasus strike.

At the Katsmala section, 4 gas profiles were made. The carbon-dioxide concentration in the subsoil sediments was 2.5 percent at the maximum.

At profile I, the values of concentration were in the 0.0-2.5 percent range. The CO_2 content found at profiles II, III and IV varied from 0.0 to 0.4 percent. The anomalous values at the northern terminus of profile IV corresponded to the axes of the geophysical anomaly. The southern anomaly section of profile IV and the northern anomalous sections of profiles II and III had independent values--they were not connected with the anomalies' geophysical axes.

From the geological point of view, the northern anomalous section of profile IV correspond to the node where three ore-bearing zones (I, II and III and the Katsmala ore-bearing zones converge. The southern anomalous section with a small dislocation corresponds to the eastern terminus of Kekhnamedan ore-bearing zone II. The northern anomalous sections of profiles II and III correspond geologically to the fracture that exits from Katsmala ore-bearing zone II and to intrusive rocks. The northern anomalous section of profile IV coincides with the zone that is most promising, according to the data of hydrogeochemical surveys, with total content of metals--copper, lead and zinc--of 100-150 mg/-liter.

The Karabchay section was covered with 7 gas profiles. The maximum carbon-dioxide content in the subsoil atmosphere was 1.5 percent. As a result of the work done at the Karabchay section, six anomalous zones of diverse shape and size were singled out.

Anomaly I is located in the southern portion of the section being studied. Sections with a contrast coefficient of more than 2 have been found within anomaly I. This anomaly corresponds to the axes of the geophysical anomalies and the lithogeochemical anomaly, and also to the hypothetical position of the ore horizon, that is, the most interesting sections in relation to the geological, geophysical and geochemical data are also reflected in the results of the gas-geochemical operations.

Anomaly II is located north of anomaly I. Sections with a contrast coefficient of more than 2 were not found here. Anomaly II corresponds to the axes of the geophysical anomaly, and also to eroded debris of ore lumps.

Anomaly III was found to the north of anomaly II. A section with a contrast coefficient greater than 2 is located at the western terminus of this anomaly. Geologically, this anomaly corresponds to eroded fragments of ore lumps, and also to fractures.

Anomaly IV was found to the west of anomaly I. Geologically, it corresponds to sandy and clayey shale rocks.

Anomaly V is found to the north of anomaly IV and also, just like anomaly IV, it is confined geologically to sandy and clayey shale sediments.

Anomaly VI, which has small dimensions, is found to the north of anomaly V and it also corresponds to sandy and clayey shale sediments.

At the Agdamkelal section 20 gas profiles were made. The maximum carbon dioxide content of the subsoil atmosphere was 3.3 percent.

At the Agdamkelal section, five gas anomalies were found (figure 1). These anomalies were noted mainly at the southwestern termini of the gas profiles and were confined to the upper thickness of Lower Aalenian sediments, which are represented by an alternation of clayey shales with intercalations of sandstones and of aleuritic sandstones. A small number of anomalous points also were found in the central and northern parts of the section being studied.

Anomalies I, II, III and IV form a single unit which extends in a northwesterly-southeasterly direction.

Anomaly I is the largest in dimensions and greatest in degree of contrast. This anomaly is in the western portion of the anomaly belt. Its contrast coefficient is 2. Anomaly I corresponds geologically to sandy and clayey shale sediments. Anomaly II is located in the eastern portion of the belt that has been discovered. This anomaly contains a section with a contrast coefficient of 2. Gas anomaly II corresponds to isoconcentrations of copper and zinc (according to secondary dispersion aureoles) of 0.03 percent.

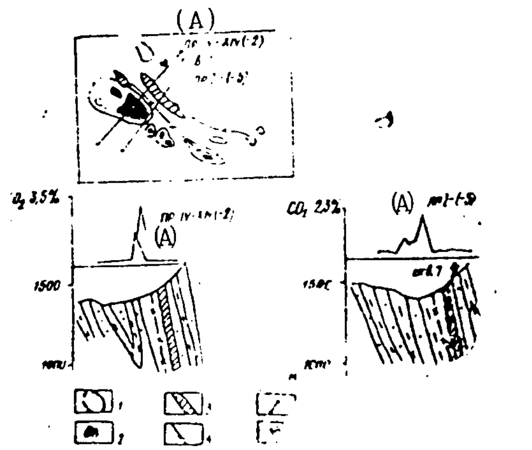

Figure 1. The Agdamkelal Section. Map of CO_2 Distribution in the Subsoil Air (made up by Yu. B. Galant, 1979). The geological content accords with data of the Azerbaijan SSR Administration of Geology.

1. Gas-contour anomalies.
2. Gas-anomaly sections with contrast coefficient equal to or greater than 2.
3. Scheme of an anomalously shaped object.
4. Axes of geophysical anomalies.
5. Profiles.
6. Sandy and clayey shale rocks.

A. Profile.

Anomaly III is located in the central portion of the anomaly belt, to the east of anomaly II.

Within anomaly III are sections with contrast coefficients greater than 2. Geologically, the anomaly being described is confined to sandy and clayey shale rocks.

Anomaly IV is the smallest in dimensions in the anomaly belt. As is the case with anomaly III, it is in the central portion of the anomaly belt, between anomalies I and III. Anomaly IV contains a section with a contrast coefficient of 2 and corresponds to sandy and clayey shale sediments.

Anomaly V is located in the northwestern portion of the area being studied. No sections with contrast coefficients greater than 2 have been observed here. Also, as with anomaly IV, it corresponds to sandy and clayey shale sediments.

With a view to developing the Filizchay and Katsdag fields safely, the distribution of natural gases was studied both by area and by horizon.

In the natural gases of the Filizchay and Katsdag sulfide fields, the following gas components were studied, CO_2, hydrocarbons (UV's), O_2, N_2, H_2, H_2S and He.

At the Filizchay field, the average CO_2, UV and N_2 content in the flushing fluid from the wells averaged, respectively (in cm^3/liter): 30.66, 1.62 and 83.64. An increased amount of CO_2 (7.7 percent) and a decreased amount of O_2 (11 percent) were noted in the atmosphere of an adit. The H_2S content in the field's waters varied from 5.05 to 11.5 mg/liter, reaching a maximum in the mine waters. An increased amount of the CO_2, H_2S and H_2 gases was noted in places remote from contact with atmospheric air and in proximity to the ore deposit.

At the Karadag field, the amounts of CO_2, H_2S, UV's and N_2 identified in the mine waters varied, respectively, from 0 to 3.55, 0.000062-0.00015, 61.22-31.94 and 7.1-9.8 mg/liter. In the mine air, the amounts of CO_2, UV's and N_2 were, in percent: 0.0-9.0, 0.000015-0.00581 and 74.2-86.8, respectively.

Within the Filizchay field, three areas were delineated for intensity of release of gases (for both carbon dioxide and hydrocarbons) from the enclosing sediments when they were exposed by a well that was being drilled.

The following were noted in regard to carbon dioxide (figure 2):

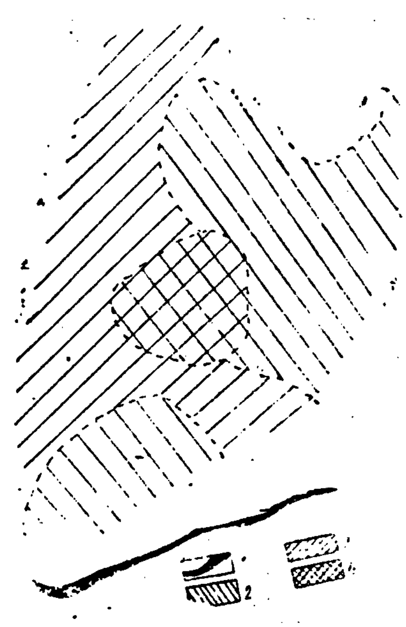

Figure 2. The Filizchay Field. A Schematic Map of the Intensity of Carbon Dioxide Manifestation. (Compiled by Yu. B. Galant, 1980).

1. The ore deposit of the area with intensity of manifestation of CO_2;
2. Less than 600 liters/m;
3. From 600 to 1,200 liters/m; and
4. More than 1,200 liters/m.

area I--with an intensity of release of 1,732.8 liters/m. The indicated area is situated basically on the eastern flank and the western portion, and it extends through its western portion to the central part of the field;

area II, with an intensity of release of 600 to 1,200 liters/m. The indicated area is located basically on the eastern flank and it extends to the central portion of the field through its western portion; and

area III, with an intensity of release of less than 600 liters/m, occupies the eastern and northeastern parts of the field, and also the southern section in the central portion.

The following were noted in regard to hydrocarbons:

area I, with an intensity of release of more than 60 liters/m. This area embraces the eastern portion and a small part of the central section of the field;

area II, with an intensity of release of 30 to 60 liters/m, is located in the central and northeastern parts of the field; and

area III, with an intensity of release of less than 30 liters/m, is located on the outskirts of areas I and II and embraces the eastern flank and also the northern and southern parts of the field.

The greatest gas saturations were the horizons at 700-900 meters and more than 1,100 meters.

At the Katsdag field, the areas that are most gas-bearing were individual areas of the eastern and western flanks and the central portion of the field, and, over the cross-section, the most gas-bearing were the horizons at 1,920 and 1,980 meters.

The gas-geochemical operations conducted enabled the following recommendations to be made:

1) That prospecting and test-evaluation drilling be performed at the Tenros-Chugak, Katsmala, Karabchay and Agdamkelal gas anomalies, primarily at anomalies with contrast coefficients of more than 2, in order to assess prospects for the presence of ore; and

2. a) That, in order to forecast the gas behavior of the Filizchay and Katsdag mining enterprises, data on study of the presence of gas be used as the basis; and

b) That the Azerbaijan SSR Administration of Geology organize gas-logging stations for studying the presence of gas in ore deposits.

11409
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OIL AND GAS

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PETROLEUM SOUGHT IN LOWER PART OF AZERBAIJAN'S KALA SUITE

Baku IZVESTIYA AKADEMII NAUK AZERBAYDZHANSKOY SSR: SERIYA NAUK O ZEMLE in Russian No 2, 1984 pp 74-80

[Article by Sh. F. Mekhtiyev and Ya. M. Bashirov: "The Problem of Prospecting for Nonanticlinal Oil and Gas Deposits in the KaS at the Southeastern Pericline of Neftyanyye Kamni, Neftyanyye Kamni-2 and Area imeni 28 Aprelya Uplifts"]

[Text] The Kala suite is the thickest of the lower-section suites of the PT [productive series]. In lithological composition, nature of oil saturation and physical and chemical properties of the fluids, it stands out sharply among the other suites. Moreover, it should be noted that its full thickness still has not been established within the Apsheron Archipelago, and new formations of it are exposed as new folds are studied and wells are deepened.

In previous years a number of exploratory holes were sunk in the Neftyanyye Kamni region with a view to studying the whole cross-section of the PT by exposing the sediments that underlie it, but not one of them reached the designed depth, for technical reasons. Beginning with 1972, deep holes (Nos 1837, 1832, 1841, 1842, 1949, 900 and others) were drilled through at the YuV (southeastern pericline], at which time the sediments of new subsuites (KaS_4, KaS_5 and others) were exposed for 150-300 meters, going through the full cross-section of the KaS. Thus, hole No 1837, after exposing the foot of KaS_3 in the depth interval of 1,448-1,490 meters, went into the upper portion of a new sandy member (KaS_4), which was about 50 meters thick. The transition here from KaS_3 to KaS_4 was marked by high electrical logging indicators (ρ_k was 15-20 Ohm·m) and the PS [potential for spontaneous polarization] curve was accurately differentiated. It should be presumed that the lowest subsuites (below KaS_4) of the hole still had not been exposed. A similar cross-section also was characteristic for hole No 1841. Here, the same as in hole No 1837, the transition from the lower portion of KaS_3 to KaS_4 (1,785-1,858 meters) was marked by high electric-logging indicators (ρ_k was 10-15 Ohm.m) and the PS curve was accurately differentiated.

The 1,730-1.750 meter intervals, which correspond to the middle portion of KaS_3, were tested, but the only result of formation testing of this object was stratal water with a high mineralization of 42.6 mg/equivalent, which is characteristic for KaS. Pontian-stage sediments were not exposed here. The consistencies of change in thickness and logging characteristics of the KaS sediments (KaS_{1-3}) that were noted in neighboring holes (Nos 1837 and 1841) were traced also in the cross-section of hole No 1949. Thus, hole No 1949, after

exposing the foot of KaS_3 in the depth interval of 1,355-1,712 meters, entered the upper portion of new sandy subsuites (KaS_4 and KaS_5) at the 1,712-1,868 meter interval, which was marked by high specific resistances, which reached 18 Ohm·m.

The cross-section of hole No 900, which is located to the far southeast of the pericline compares precisely with the cross-sections of holes Nos 1841 and 1949 of Neftyanyye Kamni and the neighboring exploration areas (holes Nos 1 and 2--Neftyanyye Kamni-2, and holes Nos 1 and 5--imeni 28 Aprelya). Hole No 900 exposed a cross-section of KaS whose rocks possessed good collector properties. The KaS_{1-3} cross-section of this hole, 340 meters thick (2,178-2,520 meters), was represented by sandy-aleurite rocks with ρ_k from 2 to 18 Ohm·m and the PS curve is accurately reflected. The KaS_3 subsuite here was started by a clayey member (2,432-2,460 meters) but its middle portion became more sandy, with a ρ_k of up to 18 Ohm·m and farther below it again replaced by clayey rocks. The foot of KaS_3 was exposed in hole No 900's cross-section at a depth of 2,520 meters, then followed the rocks of KaS_{4-5}, 230 meters thick (2,520-2,750 meters). In the 2,520-2,600 meter interval, the cross-section was sandier (ρ_k is up to 5-15 Ohm·m), while from the 2,600-meter depth it was reduced (2-5 Ohm·m). The PS curve was well differentiated. The Kala age of the above-mentioned member (hole No 900) provokes no doubts, since, in regard to fauna, it is characterized as KaS in the new exploratory areas of Neftyanyye Kamni-2 (holes Nos 1 and 2) and imeni 28 Aprelya (holes Nos 1 and 5). According to microfauna data, the age of the rock, beginning with the depth of 2,800 meters, has been determined to be Pontian.

In recent time, according to seismic-exploration data, at the far pericline of the Neftyanyye Kamni structure, several kilometers to the southeast of holes Nos 428 and 900, a new uplift presented in the form of a structural projection that has been named Neftyanyye Kamni-2 by geophysicists has been observed.

From the results of OGT [common depth point] work (A. B. Abasov and I. L. Chernavina, 1977), it follows that the southeastern pericline of the Neftyanyye structure forms two branches. The first, the north one, is coupled with the structure imeni 28 Aprelya through a small saddle; the second, the southern one, which is elongated, stretches in the direction of the structural projection imeni Ushakov. A comparison of the OGT work (1977) with MOV [reflected-wave method] studies previously performed points to a definite divergence in the details of the area's structure. In relation to the results of drilling hole No 1, the geophysicists recommended that two additional exploratory holes, Nos 2 and 3, be sunk on the southeastern percline of the Neftyanyye Kamni fold (in the region of the presumed projection).

In accordance with OGT seismic exploration in 1979 (N. B. Akopdzhanova and A. G. Ragimov), the tectonics of the Neftyanyye Kamni-2 area were refined in the light of drilling data (hole No 2), which pointed to the presence in the dome of two lengthwise dislocations, along which block II, where hole No 2 was located, proved to be lowered in relation to block III, and this is also confirmed by our constructions. Holes (Nos 1 and 2) which were drilled in order to clarify the nature of the cross-section and the petroliferousness prospects of the PT's sediments at the southeastern pericline of the Neftyanyye Kamni structure were without result. Hole No 1, which was sunk at the submerged

portion of the structure, exposed the full thickness of the Kala suite. The middle portion of the cross-section (4,625-4,530 meters), which corresponds to KaS_2, consisted of unsorted rocks (mixed sandy-aleuritic-clayey rocks, whose particle content for each type does not exceed 50 percent) with higher specific resistances of up to 30-40 Ohm·m, and during formation testing only an influx of water was obtained--12 m^3/sec. The cross-section's lower interval 4,670-4,671 meters) was composed of large fragment-type rocks with high resistances of up to 30 Ohm·m. This interval was not tested. Below, the KaS_3 subsuite, 90 meters thick, was exposed, formation testing of which was performed in the 4,727-4,708 meter interval and stratal water with a flow rate rate of 25-30 m^3/sec was obtained. From a depth of 4,780 meters, at the bottoms of KaS_3, new subhorizons (KaS_4-KaS_5) appeared along an incomplete thickness. No cores were raised here for petrographic study, but, according to the configuration of the KS [apparent resistivity] and PS curves (ρ_k was up to 15 Ohm·m), it can be supposed that the sediments that underlie the PT still had not been exposed. After hole No 1 produced negative results, hole No 2 was sunk 2-3 km to the northeast of it, in the raised part of the structure. with the bottom-hole at 4,600 meters, it exposed the full KaS_{1-3} cross-section and the horizons which had appeared again in the 4,080-4,525 interval, and below, according to microfaunal data, Miocene sediments (diatoms) follow. The KaS_1 cross-section (hole No 2) consisted of an alternation of sandy-clayey rocks 115 meters thick, with low resistances, down to 2-4 Ohm·m. In the upper portion of the cross-section of the KaS_2 subsuite, ρ_k reached 7-8 Ohm·m. The middle portion of the KaS_2 cross-section (4,243-4,305 meters) was represented lithologically by clayey-aleuritic sand, during the formation testing of which stratal water with a total mineralization of up to 58 mg/equivalent was obtained. The lower-lying subsuite (KaS_3) consisted of aleuritic sand with a resistance of less than 10-13 Ohm·m. This formation, just like object KaS_2, was characterized by microfauna as the bottoms of the PT. The roof of KaS_4 in this hole was exposed at a depth of 4,425 meters, with a thickness of 65 meters and a ρ_k of up to 15 Ohm·m. Below 4,525 meters, the cross-section consisted of an alternation of gray, densely calcareous clay and was characterized by microfauna as Miocene sediments (diatoms). No Pontian sediments were exposed in this hole.

In order to break down into detail and to establish the structural tie among the structures of the southeast pericline Neftyanyye Kamni-Neftyanyye Kamni-2 and imeni 28 Aprelya), we selected and analyzed all the geological and geophysical data. Doing so enabled us to construct a new variant of the structural map and a number of geological profiles of these fields. The data of seismic exploration (1976-1981) also were used to construct the maps and profiles. The stratigraphic tie of the horizons was accomplished on the basis of the data from drilling holes Nos 1832, 1837, 1841, 1842, 428, 300, 125 and 900 in the Neftyanyye Kamni area, holes Nos 1 and 2 at Neftyanyye Kamni-2 and Nos 1 and 5 at imeni 28 Aprelya.

It is obvious from the graphic data that has been constructed that these areas are complicated by large longitudinal and lateral dislocations and are broken down into three separate tectonic blocks (blocks I, II and III). Block II, at which holes Nos 1 and 2 are located, proved to be lowered relative to blocks I and III by 700-800 and 300-500 meters, respectively. Deep drilling of hole No 1 was started at the northwestern pericline of the imeni 28 Aprelya structure, which is located 10-12 km from the Neftyanyye Kamni area, with the

mission of finding the petroliferousness of the PT horizons down to the KaS, inclusive. With the bottom-hole at 4,250 meters, the hole exposed the complete cross-section of the PT. The cross-section of KaS_1 (3,895-3,975 meters) and the tops of KaS_2 (3,975-4,005 meters) were represented lithologically by an alternation of clayey and sandy members, with low specific resistances down to 5-6 Ohm·m.

The lower interval (4,010-4,100 meters) became somewhat sandy, and the ρ_k was raised to 10 Ohm·m. During formation testing of the 4,164-4,170 meter interval, which consisted of light-gray and finely grained sandstone, a weak odor of gas was noted, and, at the 4,152-4,110 meter interval, water with an oily film emerged. From a depth of 4,200 meters, below KaS_3, the upper portion of the new subhorizon (KaS_4, which was less than 30 meters thick), with high resistances ρ_k of up to 17 Ohm·m, was exposed. No rock samples were taken from the indicated interval for study. The 4,255-4,260 meter interval was assigned to the Miocene (Sarmatian), according to downhole data.

Because hole No 1 proved to be beyond the contour of petroliferousness, a slant hole, No 4, was drilled in the dome portion of the structure with an inclination from the vertical of 1,400 meters from the first platform. During formation testing in this well, horizon X of the Balakhany suite gave a flowing influx of oil of more than 200 tons/sec at 3,455-3,423 meters. At the bottom-hole (3,600 meters), further drilling of the well was stopped because the drilling tool stuck. Two more holes (Nos 6 and 7) were drilled through from this platform. They exposed an "interruption" suite, and during formation testing they produced 300 and 500 tons/sec of crude, respectively, confirming the petroliferousness of the southeastern wing of the Field imeni 28 Aprelya. Hole No 5, which was situated in a raised portion of the structure, was drilled, taking these positive formation-testing data of the wells into account. The hole exposed the full cross-section of the PT down to the subjacent sediments (3,720 meters), inclusive.

Judging by electric logging, the suite most saturated with oil and gas was the "interruption" suite (2,820-2,930 meters) with positive electric-logging indications-- a ρ_k of up to 10-12 Ohm·m. Below on the cross-section, the clayey-sand cross-section was replaced by more clayey facies (ρ_k of less than 5 Ohm·m). Only in the lower part of the KaS's cross-section, a clayey-sandy member 40-50 meters thick) with specific resistances of up to 8-10 Ohm·m was noted. Only an insignificant gas influx was obtained from the indicated object by formation testing, while from the 2,873-2,899 meter interval (the "interruption" suite), a flowing influx of oil and gas was obtained.

Because of what has been said, it becomes necessary to find out the nature of change in the thickness of the KaS, which is considered the base suite of the productive series of the Apsheron petroliferous region, and to establish the cause of the sharp increase in its thickness, from zero (the Kala station) to 500-700 meters (the Area imeni Azi Aslanova--Neftyanyye-Kamni-2).

As is known, the sediment-accumulation basin of the PT's lower section is marked by frequent geological shifts and rhythmicity of sedimentation, which were reflected in the suite's thickness. It should be noted that again the subsuites (KaS_4 and others) at the bottoms of the KaS in the area we examined

(from dry land to the sea) were exposed unevenly and basically were deposited on submerged portions of the structure, that is, the pinching-out of the sediments of various subsuites occurs in definite directions.

All the factual material and the results of detailed geophysical study and deep drilling that have been set forth testify that possible oil and gas accumulations within the structures of the southeastern portion of the Apsheron Archipelago--from dry land (the Kala station to the seawater bodies (Neftyanyye Kamni and imeni 28 Aprelya)--can be observed not only in anticlinal-type traps but also in zones of stratigraphic lensing-out of various PT horizons and suites.

A successive lensing-out of the lower KaS subsuites (KaS_{1-6}) is observed toward a regional rise of the strata in a southeasterly to northwesterly direction, within individual uplifts. The prospects for petroliferousness here are apparently connected with the KaS foot suites (KaS_4, KaS_5 and KaS_6), which are pinched out. A graphic example of stratigraphic deposits are the oil deposits in the KaS of the Kala-Turkyany-Zyrya field, which are confined to the southeastern pericline of the fold that pinches out upward along the rise of the formations. Confirmation of the presence of nonstructural-type hydrocarbon deposits in the KaS in areas of stratigraphic pinching-out is the fact that gas and condensate are obtained in the southern portion of the southeastern B. Apsheron pericline. The discovery of new and possibly petroliferous nonstructural-type subsuites under KaS_3 (KaS_4, KaS_5 and KaS_6) is the next task for further prospecting and exploration.

Not only the wing portions of various structures but also the pericline's slopes are favorable for prospecting for stratigraphic-type oil and gas deposits. The far-off southeastern periclinal submergence in the area where holes Nos 428, 900 and others are located becomes of special interest for exploration. Hole No 900 (Neftyanyye Kamni), which exposed the full cross-section of the Kala suite (KaS_{1-5}), which is about 600 meters thick and has good collector properties and positive logging indicators, in the upper portion of the KaS cross-section, is one of the deepest. Below in the cross-section the clayey-sandy cross-section is replaced by more clayey facies.

Positive logging indicators are characteristic also for the tops of the KaS (KaS_2) of hole No 428. Judging by electric logging, some Kala suite intervals that are marked by high electric-logging indicators remain untested, and so the status of oil and gas saturation in these sediments has not been learned.

What was said above makes it clear that in the southeastern pericline region of Neftyanyye Kamni there are reasons to hypothesize the possible presence of new horizons, especially in the KaS cross-section, with which lithologic stratigraphic oil and gas deposits can be associated. Because of this, we find it desirable to recommend that two prospecting holes be sunk to a designed depth of 2,500-3,000 meters, at the southeastern pericline in the area of holes No 900 and 428, for the purpose of uncovering the full thickness of the PT, down to the KaS inclusive (figure 1).

The petroliferousness of the PT's sediments at the far southeastern periclinal terminus in the area of the hypothetical projection (Neftyanyye Kamni-2) that was found by seismic exploration (MOGT [common depth point method]) at the

bottoms of the productive series, has not yet been adequately elucidated. Hole No 1 was sunk in this section, exposing the full cross-sections of the PT and KaS, inclusive, but formation testing gave no positive results During formation testing at the 3,808-3,800 meter interval, which corresponds to the NKG suite, with positive indicators for electric logging (ρ_k was up to 50 Ohm·m), 50-60 m^3/sec of water with an oily film was obtained, and stratal water--60 m^3/sec--was obtained from the PK suite (4,378-4,364 meters). It is noteworthy that the sample was withdrawn when the wells were flowing, with a release of gas. The KaC_2 object was formation-tested in the 4,625-4,588 meter interval, as a result of which brine water (12 m^3/sec) with an oily film and weak release of gas also was obtained.

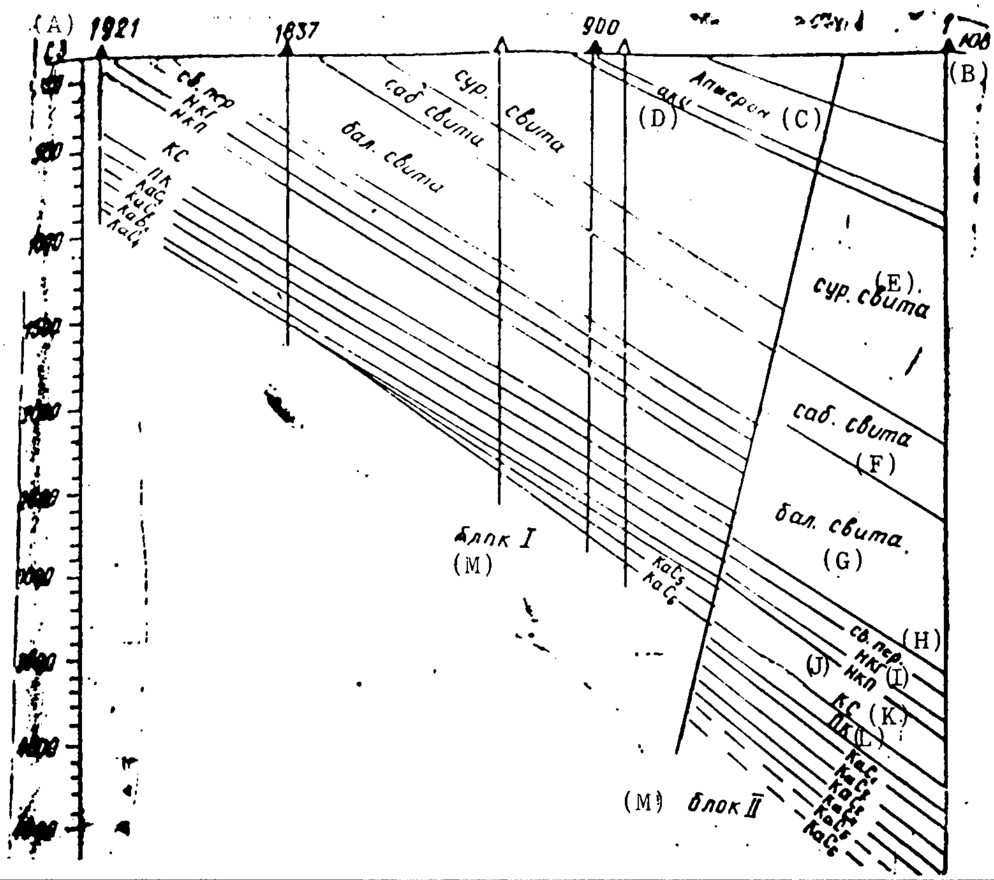


Figure 1. Geological Profile of Neftyanyye Kamni and Neftyanyye Kamni-2 Uplifts.

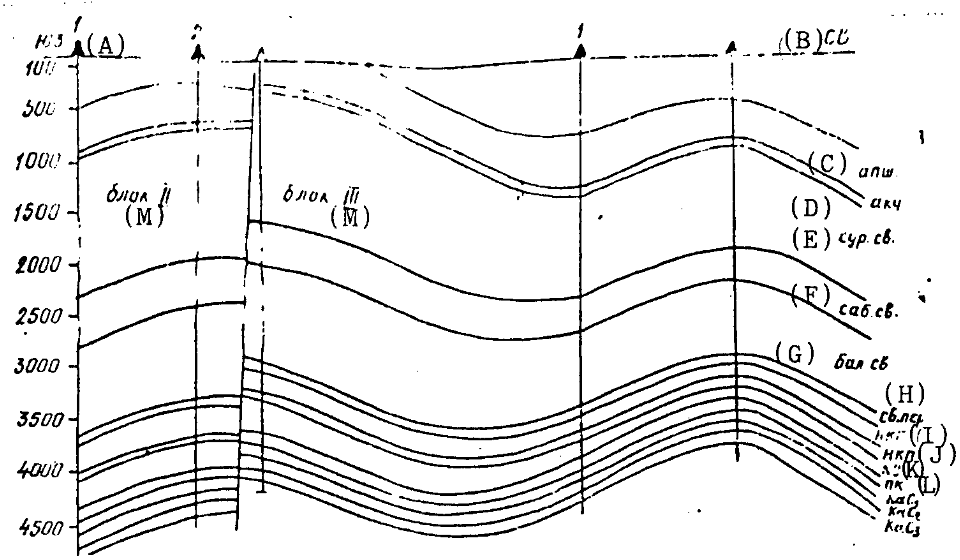
A. Northwest.
B. Southeast.
C. Apsheron.
D. Akchagyl.
E. Surakhany suite.
F. Sabunchi suite.
G. Balakhany suite.
H. "Interruption" suite.
I. NKG.
J. NKP
K. KS
L. PK.
M. Block

Because hole No 1 turned out to be in a submerged portion of the structure, a second hole (No 2) was sunk in a more raised structure, 2.5 km to the northeast of hole No 1. This hole, just like No 1, exposed the full cross-section of the PT down to the underlying sediments, inclusive, but no output was obtained.

It seems to us that if oil and gas deposits are to be found at Neftyanyye-Kamni-2, it would be desirable to design one hole--1-1.5 km from the previously drilled hole No 2, 3,500-4,200 meters deep and in a more elevated portion of the uplifted block (III). The roof of KaS possibly will be exposed in it at a depth of 3,500-3,700 meters (figure 2).

Figure 2. Seismogeological Profile of Neftyanyye Kamni-2--imeni 28 Aprelya.

[Key is the same as for figure 1.]



The results of formation testing of some holes (2, 4, 6, 7 and 12) showed that at the new explored Area imeni 28 Aprelya, petroliferousness had been established on the southwestern wing of the fold, output of which was obtained from the PT's upper section. The degree of oil and gas saturation found for formations of the upper section (the "interruption" suite) at some holes (Nos 2, 4, 6, 7, 8 and 12), which were located on the southwestern wing of the fold, testify that there may still be unused oil and gas resources also in the lower section of the PT. It should be noted that, of the holes enumerated, not one has exposed a cross-section of the PT's lower suites.

In considering the results of formation-testing of the holes, it would be desirable, with a view to detecting oil and gas deposits in sediments of lower, base suites (the PK and KaS) of the productive series, to aim further work at the area where hole No 5 is located (the dome portion of both the southwestern region, where holes Nos 2, 4, 6, 7, 8 and 12 are located, and the northeastern wings of the fold).

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11409
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OIL AND GAS

SOUTH CASPIAN DEPRESSION GEOLOGICAL REGIONALIZATION STUDIED

Baku IZVESTIYA AKADEMII NAUK AZERBAYDZHANSKOY SSR: SERIYA NAUK O ZEMLE in Russian No 2, 1984 pp 137-138

[Article by Z. A. Buniat-Zade, scientific-secretary of the seminar conference, "The Petroleum-Geology Regionalization of the South Caspian Depression"]

[Text] A seminar conference on this problem, which is most interesting from a scientific and practical point of view, was organized by the Institute of Geology imeni Akademik I. M. Gubkin of the Azerbaijan SSR jointly with PO Azneft' [State Azerbaijan Oil Industry Production Association] and VPO Kaspmorneftegazprom [All-Union Caspian Offshore Oil and Gas Industry Production Association] and was held in Baku 16-18 November 1982.

The main purpose of the conference was to search for an optimal solution of the problems of the fuel and power resources of the country as a whole and of stabilization and increase in oil recovery in Azerbaijan, the urgency of which was especially emphasized in the historic decisions of the 26th CPSU Congress, the 30th Azerbaijan Communist Party Congress and the October 1982 Plenum of the republic's Communist Party Central Committee. On this basis, the seminar conference was faced with the task of discussing basic questions of the common problems of petroleum regionalization, integrated generalization and analysis of geological, geophysical and aerial- and space-survey data on the peculiarities of the geological structure and petroliferousness of the underground of Azerbaijan and adjacent Caspian Sea water areas, and examination of urgent problems of classifying petroliferous lands, superdeep deposits and collector and cap rocks, all in the light of recent scientific and practical achievements, with the participation of leading specialists of scientific-research institutions, vuzes and production organizations of the city of Baku and of the country's other petroleum centers.

About 200 specialists of scientific institutions and vuzes of Moscow, Kiev, Ashkhabad, Lvov, Odessa, Nebit-Dag and Shevchenko and of a large number of Baku's scientific and production organizations and vuzes participated in the seminar-conference's work.

Based upon the numerous papers received prior to the conference's start, the conference's organizing committee (Academician Sh. F. Mekhtiyev was chairman, his deputies were A. N. Guseynov and Professors F. G. Dadashev and Kh. B. Yusuf-Zade), published a collection of papers, "Neftegazogeologicheskoye rayonirovaniye Yuzhno-Kaspiyskoy vpadiny" [Petroleum Geological Regionalization of the

South Caspian Depression] (Baku, 1982, 138 pages), which embraced 76 works. Included in the seminar-conference's program for discussion were 60 reports.

A discussion of the new "Karta neftegazonosnosti Azerbaydzhanskoy SSR" [Map of the Petroliferousness of the Azerbaijan SSR], which was compiled by a collective of Azerbaijan oilfield workers and specialists (Academician Sh. F. Mekhtiyev, Academician F. M. Bagir-Zade, Professors F. G. Dadashev and S. G. Salayev and Candidates of Geological and Mineralogical Sciences A. I. Aliyev, Z. A. Buniat-Zade, A. N. Guseynov and Kh. B. Yusuf-Zade) and was prepared specially for the conference, based upon new and rich factual data on the geological structure and petroliferousness of the underground of Azerbaijan and the adjacent Caspian Sea water body that was obtained as a result of geological and geophysical prospecting and exploration of the past 25 years and of the newest scientific generalizations, provoked the participants' special interest. Reflecting with precision the main peculiarities of the geographical spread of and prospects for Azerbaijan's petroliferousness, this map was designed for use in a comparative assessment of the prospects for petroliferousness of the territory of Azerbaijan and the adjacent water area of the Caspian and in the scientific substantiation of an optimal strategy for prospecting and exploration therein over the long term.

Many of the specialists who spoke at the seminar conference (Academician G. N. Dolenko from Lvov, Doctor of Sciences V. A. Krayushkin from Kiev, Candidate of Sciences A. G. Arkhipov from Moscow, and others) expressed the hope that it would be expedient to publish this map, which was of great interest to geologists not only of Azerbaijan but also of other petroleum regions of the country, as quickly as possible.

It was also noteworthy that conference participants recommended that Azerbaijan's geologists and oilfield workers, jointly with colleagues from scientific-research and production organizations of Georgia and Turkmenia, make up a "Map of the Petroliferousness of the South Caspian Province," using identical methodics.

Maps of the fault tectonics of the South Caspian and of West Turkmenistan that were shown at the conference also stimulated great interest by the participants.

On the whole, the reports that were presented at the conference and the discussion of them indicated that the interdependent special examination of the petroleum regionalization of the South Caspian depression against the background of the status and various aspects of the general problems of such a regionalization was extremely fruitful. In so doing, it was indicated that the basic tectonic principle of petroleum regionalization must be supplemented by historical and genetic analyses of the basins that have developed, singling out centers for the forming of petroleum and discovering the peculiarities of the forming of both separate natural reservoirs and accumulation zones of gas and oil.

The series of reports on classifying petroliferous land, superdeep deposits and collector and cap rocks and the exchange of opinion thereon indicated that the prospects that numerous petroliferous areas and provinces in the Soviet Union are associated with superdeep horizons, because of which it is

necessary to intensify the search in this direction for both theoretical and practical knowledge.

The decision of the seminar conference, which was adopted unanimously, recommended that research on the questions examined be intensified, and that, along with All-Union conferences on the problem of the petroliferous regionalization of the Soviet Union as a whole, similar conferences be held periodically in various parts of the country with purposeful seminars on petroleum-geology regionalization of the appropriate regions.

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OIL AND GAS

YAKUT ASSR TIMBER SUPPLY, DEMAND PROBLEMS DISCUSSED

Moscow PRAVDA in Russian 23 Nov 84 p 2

[Article by L. Filippov, minister of the Yakut ASSR fuel industry:"Paradoxes of Planning" under the rubric "A Letter to PRAVDA"]

[Text] Yakutiya, which is huge in terms of area, is still sparsely populated. The task of our industry's enterprises is to supply fuel to the many cities and settlements here. The dynamics of life are such that frequently demands are reduced. In connection with the conversion to progressive forms of fuel, such as gas, coal and fuel oil, there became less need for firewood, especially near the areas where the above fuels are recovered. At the same time, the demands for lumber are increasing with the development of capital construction.

Now our ministry has come out with a draft for the 1985 national economic plan in which there is a proposal to reduce the overall volume of timber felling and transport to 843,000 cubic meters in connection with the reduced demand for firewood. The fact is, in the last three years the amount of timber felled for fuel has sharply diminished. Besides that, in the last year, letter-requests have come in from the rayispolkoms of eight of the republic's rayons, requesting the reduction, by 23,000 cubic meters, of fuel wood being cut.

On the other hand, the rayispolkoms are requesting that the amount of timber felled for lumber be increased, but they are not receiving their funding allocations. Let us assume that a rayon has many schools, kindergartens, clubs, and a lot of housing, all made using wood. The rayon is allocated an average of 300-400 cubic meters of wood for repairs. After sawing, only 150-200 cubic meters of lumber are produced. Other departments are faced with the identical situation. And consequently, independent wood-cutters are now multiplying like mushrooms; people with no special equipment, and moreover who, as a rule do not observe correct forest utilization procedures.

In the RSFSR Ministry of the Fuel Industry and consequently in the RSFSR Gosplan department, they say to us,"What of your 23,000 cubic meters? There's an unrealistic plan of a million cubic meters [of fuel wood] for the ministry overall." I hear these words and don't believe my ears. How about that! For we're planning [setting plans] for ourselves, not someone else.

But in the RSFSR Gossnab Department of Timber Production they are announcing that no increases in lumber procurement will be permitted. They say there is no demand for lumber in Yakutiya. I take umbrage at that: "What do you mean, no demand? We're not even meeting the needs of the local soviets." Gossnab tells me, "Obtain the funds." I say, "But you won't give them to us...." These arguments have to be repeated here in spite of the fact that the problem, as they say, needs no comment.

Gossnab is sticking to its guns. Then I play my final trump-card: "Tell me why the number of independent wood procurers is growing? Why are all of them seeking this very lumber, like prospectors looking for gold? Why, of the 5.6 million cubic meters of timber cut here every year, does over half go to the independents?" They announce to me: "Don't set riddles here. We know quite well that there is no demand for your lumber."

And while I was in Moscow I caught myself thinking, "Why have they called me here? They could have sent us the plan figures and everything, by mail."

As a former first secretary of the party raykom of one of the most heavily forested rayons of the republic, I can state flatly that there is great demand for lumber in Yakutiya. USSR Gosplan does not permit the Yakutles Association to increase its timber allocation. And that is exactly why the Yakutzoloto [possibly Yakut Gold-Mining], the Vilyuygesstroy [Vilyuyskaya Hydroelectric Power Station Construction], Yakutugol'stroy [Yakutiya Coal Mining Facility Construction], and other associations are involved with independent timber procurers.

From the standpoint of the interests of the State, the Yakutles Association should satisfy the industrial lumber and sawn timber demands of all union and union-republic departments. And the Yakut ASSR Ministry of the Fuel Industry can take care of the industrial lumber needs of the republican departments and the local Soviets of national delegates.

And so everyone, this way, would be involved with their own immediate concerns. This is exactly the spirit in which Yakut ASSR Gosplan has repeatedly appealed to RSFSR Gosplan, but has obtained no support.

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OIL AND GAS

TYUMEN PRODUCTION PROBLEMS, SOLUTIONS DISCUSSED

Moscow PRAVDA in Russian 21 Nov 84 p 2

[Article by V. Lisin, PRAVDA correspondent, in Tyumen: "Don't Increase the Regulations", under the rubric, "Word and Deed: Let's Check Up On How Obligations Have Been Carried Out"]

[Text] The Tyumen oil workers, utilizing their internal reserves, decided in 1984 to recover 1.2 million tons of valuable hydrocarbon raw materials in addition to the plan. This figure, which they came up with, became part of the oblast's and the republic's obligations. The end of the year is close at hand. How are the obligations being realized? What has been done, and what remains to be done?

Some time ago, in the hall of the Tyumen oil workers' Palace of Technology and Culture, an event was celebrated: the recovery, in the oblast's oil fields, of the three-millionth ton of petroleum. It was by no means an ordinary event. Indeed, in only two decades, this region has been turned into the main fuel and power production base of the country, from which the national economy gathers over half of its recoverable hydrocarbon raw material. Over 50 fields have been developed, about 100 million meters' worth of wells have been sunk, over 25 billion rubles' worth of capital investments have been assimilated and over 20 million tons of fuel have been recovered above the five-year plans. In the old days, the unpopulated expanse of the Tyumen North and the swampy taiga were crisscrossed in all directions with roads and rail lines, large-capacity pipelines and power transmission lines. Oil flares flashed from the new cities and settlements....

Yes, the Tyumen oil workers, and with them, everyone who helped build the "country" of Tyumen, had a right to this holiday. There was music and there were flowers. Speeches were made. Only the applause, in spite of expectations, was a bit anemic. Many of the participants of the gathering listened to the triumphant speeches with no particular enthusiasm, and indeed, sometimes with even a certain amount of embarrassment. This was easy to understand for anyone who knew the state of affairs. The Siberians, alas, had not managed to meet the obligations they had taken on for this year, and had fallen behind the plan for recovery. Moreover, their lag had not been reduced, but had increased.

The fact that this year is going to be a difficult one for the oil workers has been no secret--the recovery shortfall in the area began to show up a long time ago. True, in the beginning, they corrected the plan by the expedient of reducing it, having transferred the lagging section onto the shoulders of other oil regions. Then, the Tyumen oil workers lagged so far behind that rescuing them became difficult. What was needed were measures which would bring in-house reserves into operation.

And so Glavtyumenneftegaz [Main Tyumen Oil and Gas Administration] developed just such measures and the industry headquarters approved them. It now appeared that affairs would be going all right. But such was not the case. The daily recovery level became less than last year's. And even though the development of this most important region has been given, and is now being given a great deal of attention, proper recovery levels have not yet been reached. Why? The measures developed by Glavtyumenneftegaz, were worked out basically in offices, without an in-depth study of their potentialities, and with no input from the collectives themselves. In other words, the direct performers--the workers and specialists of the oil and gas extracting administrations, found themselves on the sidelines, hurriedly consulted with, and their suggestions either shelved, or totally forgotten about. And it is no accident, for example, that in the list of immediate measures, some showed up which they could have managed without in the fields, and on the other hand, the measures on which a speed-up in recovery actually depended were never put to use.

Or take this fact: construction workers were charged with building a number of new fields, for the majority of which there was no planning documentation, not to mention the necessary materials and equipment. In such conditions, how can the construction workers be expected to work smoothly?

More than anything, the oil workers today are in need of study of , and sensible dissemination of, advanced experience. This includes experience in bringing lagging collectives up to plan norms. By the way, this experience is not being secured either.

Take, for example, the seventh field in in the Belozerneft' Oil and Gas Extracting Administration. Until recently it was considered just about the worst. The collective finished the first quarter of this year, too, with low indicators. The second quarter has begun, and here, favorable changes have been noted. No magic wand has been used here. There are concrete steps which can be taken to improve the administration and organization of labor and increase the creative activity of the people. In the field, they have changed over from the narrow specialization which hampered coordination of the work forces of allied skills to the establishment of integrated recovery brigades. Fitters, welders, extractors and boiler operators have been joined into a unified collective working on a job-rate contract. And soon there was a noticeable increase in the personal interest of people in the results of their work, and there was a decrease in the number of breakdowns of the pumping

which bring up the raw materials from the earth's depths. In fact, they used to stand idle for days, awaiting minor repairs. Nowadays, wages for maintenance personnel are set in direct relation to the quantity and quality of the recovered oil.

Naturally, we've all heard a lot about the experience of the Belozersk workers; a lot of noise has been made about it. It was formally backed up in the main administration and in the ministry. But up to now it still remains within the framework of one administration, and even more precisely, in that very same seventh field. There is a single reason: the initiative was not supported by a vital, persistent organizing operation. Having approved the initiative (N.B. in the form of a special regulation), in the ministry they considered the affair closed. And the same in the main administrations and associations. The specialists didn't take the trouble to explain the essence of the initiative sensibly in the field collectives, that is, where these innovations need to be introduced, nor did they give any assistance in following up on the experience in practice of the lead workers. By the way, ministry and main administration workers more often appear out there in the role of various checkers than as immediate organizers of a new type of operation. At least, that's what the oil workers themselves think.

And that is not the reason knowledge of the local state of affairs leaves much to be desired. Thus, according to the departmental records, downtime in the fields is not close to being eliminated. And that's what showed up from a check carried out by national inspectors in the Khanty-Mansiyskiy Okrug, where leading oil recovery is going on. Many of the wells are idle; yet frequently only half the work time in the well-servicing brigades is used. As attested to by three foremen of these brigades, from the Sutorminskneft' Administration, Yu. Vladimirov, A. Azimov and A. Bulgiyev: "Today we can't speak as though we had done everything possible to raise recovery levels. Most often the tons being lost at low-yield wells are only stopped, but we can't take the measures we need."

It has been a long time since the Sutorminskneft' Administration has achieved planned recovery norms. The tenor of the talk has been as though the yield of the wells has merely been below plan levels. But the field personnel do not agree with this. And not without foundation. As an example, right now 17 wells are shut down, this being equal to losses of 400 tons of oil per day. The well servicing department numbers 11 brigades, and a 12th is being organized. But how has the work been organized? Half the people work by hand, there being not enough tools.

Unfortunately, the work shutdown of the Sutorminsk brigades is not an isolated occurrence. This can be ascertained by the fact that right now in Western Siberia there are over 2000 wells, all of which are capable of producing oil, all of which are shut down. And this by virtue of low-quality or untimely repair.

Advanced experience is the key factor in helping bring laggards up to par. And how does the situation here apply to that? A few years ago the brigade under the celebrated Hero of Socialist Labor G. Levin was one of the first to

break through the barrier of 100,000 meters of well footage sunk for one year. Thereafter followed the collectives of other fast-working foremen, such as A. Shakshin and G. Petrov. These brigades, adopting each other's experience, set the tone for competition. There was a lot of talk about the need to multiply these examples. But in fact? Yes, there are "stars" from the Levin "school"--V. Sidoreyko, A. Shukyurov, Yu. Gerner and A. Puminov. However, the working methods used by these outstanding men are not utilized widely, and so the great mass of drilling personnel have not learned them. That is why the state of affairs as regards drilling has remained practically unchanged, and well construction time has not been shortened. And some collectives have even lost the positions they had earned. So G. Levin left the brigade (to take charge of a drilling operations administration), and his brigade soon slid back among the laggards.

In the main administration office, they handed me a bulky folder. Inside, documents were fastened which had been received jointly by the management and the sectoral trade-union obkom. The documents were related to the development of competition among the oil workers, and to propaganda about advanced experience. Were one to judge by this, one might conclude that the oil workers are actively fighting for the introduction of methods to increase oil recovery from the formations, and to decrease well construction time, etc. In the Nizhnevartovskneftegaz Association alone, over 270 different initiatives have been recommended for implementation in three years. In a word, everything is completely satisfactory. But in actuality, there are dozens of various impediments which hinder the achieving of high results. In the Sutorminskneft' Administration, the recovery brigades have had no monthly assignments for a long time, and have, in essence, been working blind. Until now, no records of produced output have been kept, and there is a lack of modern measuring instrumentation. According to the records, it turns out that everything is proceeding smoothly, and the accounts have been set aright.

The Tyumen oil workers have plenty of room for growth. And there is no doubt that they, using the experience of their betters as a foundation, know how to use that experience.

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COAL

VORTEX COMBUSTION PROMISING FOR LOW-GRADE COALS

Moscow IZVESTIYA in Russian 21 Oct 84 p 2

[Article by A. Illarionov, IZVESTIYA correspondent, Novosibirsk: "Harnessing the Fiery Whirlwind"]

[Text] It must be said right away that high-quality coals are not used in modern thermal power generation. Thermal electric power stations are receiving more and more low-grade coal. The Kansk-Achinsk coals are not simply difficult to use, but are also of erratic nature. They have low calorific power and high moisture content, freezing during winter into a solid monolith. Despite all these shortcomings, the Kansk-Achinsk coals have a definite advantage. The reserves of these coals, which occur right at the surface, are enough to supply all the presently operating power stations for several centuries.

No, the power industry does not plan to burn all the reserves of these coals. Scientists are determinedly searching for ways to produce liquid fuel, a valuable raw material for the chemical industry, from these coals. However, over the short term, these coals will be used in the power industry. To burn these coals with the proper efficiency, steam boilers must be improved so that they can operate reliably on this erratic fuel.

Due to the great electricity demand in the country and also to the efficiency of large generating units, Kansk-Achinsk coal should be used in boilers producing up to 3,000 tons of steam per hour. However, a traditional boiler of such capacity would be 120 (!) meters high. The boiler's piping alone would weigh 20,000 tons. Its combustion chamber would be the size of an average concert hall. It would be very difficult to control the temperature in various parts of such a large combustion chamber. Consequently, it would be impossible to ensure high efficiency for such a large boiler. Higher nitrogen and sulfur oxides emissions would be another problem with such a boiler.

The solution is to burn low-grade coal in compact combustion devices. This would significantly reduce the size of the boilers and save hundreds of thousands of tons of high-quality metal, thereby reducing the costs of building new high-capacity electric power stations.

One realistic way to improve large boilers is to use vortex combustion--a method that was developed in our country.

The boiler equipped with a vortex combustion chamber at TETs-3 in Novosibirsk is the latest in a whole series of boiler designs by the Central Boiler and Turbine Institute. These designs were first tested with small-scale models using fuel oil. They were then tested with Donbass and Kuzbass coals, and, finally, with Kansk-Achinsk coals.

During the installation, I saw its structures, which had not yet been covered by high-temperature coatings and thermal insulation. I was able to enter the combustion chamber and see how it will operate.

Steam pipes encircle the lower part of the combustion chamber, forming a horizontal cylinder about 4 meters wide and 16 meters long. Obviously, it's much smaller than a concert hall.

The fuel mixture is supplied in a way that causes it to whirl along the combustion chamber walls. This supports a continuous fiery vortex with a core temperature of up to 1,500 degrees, efficiently and evenly burning the low-grade coal.

As surprising as it may seem, for all the apparent abundance of metal, the new boiler weighs one third less than the traditional boilers operating beside it, although the new boiler's output--500 tons of steam per hour--is about one third higher...

These are the main, although not the only, distinguishing features of its design. Another problem is that the slag from the Kansk-Achinsk coals adheres, or "cements itself," to the combustion surfaces. The surfaces can become so covered with slag that it can negate all the other advantages of the unit. This is why the boiler is equipped with various internal slag-removal systems.

Specialists say that modern boilers are very particular about their "food." Each needs its own type of coal. However, the coal composition varies as a giant open-pit mine is developed. One solution is to provide a constant fuel content by establishing special intermediate storage areas. Another solution is to make the combustion chamber adaptable to various types of coals. Nazarovo, Berezovka and low-grade Kuzbass coals were tested in the new boiler. The results were encouraging: the new boiler can be "omnivorous." However, it is very important to thoroughly test the new boiler with the most difficult coals.

In a separate room next to the usual boiler control panel is an experiment control panel equipped with measuring devices and recorders. Additional new measurement methods, developed by the Central Boiler and Turbine Institute, are being used here.

The vortex-combustion-chamber boiler being tested in Novosibirsk represents another advance in the understanding of coal combustion. It is also an advance in controlling this complex process and is another step toward the

series production of new, high-capacity, small-size boilers that consume the most difficult coals.

There was a time when many people thought that the increase in cheap oil and gas production would solve the future energy growth problems. Interest in the study of coal combustion waned. Time has returned coal to its place in power generation. This was emphasized at the All-Union Conference on Organic Fuel Combustion which took place in Akademgorodok. The eminent scientists who led the conference were academicians Ya. Zel'dovich, S. Kutateladze and M. Styrikovich.

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COAL

LAGGING MINING CONSTRUCTION IMPROPERLY BLAMED ON SHORTAGES

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 9 Dec 84 p 2

[Article by Ye. Leont'yeva, SOTSIALISTICHESKAYA INDUSTRIYA commentator: "Causes and Excuses: Why Mines Are Built so Slowly"]

[Text] About 10 years ago, the USSR Coal Ministry took on construction responsibilities. The decision was made not only to mine coal, but also to design and construct mines. In general, they planned to build better and faster for coal miners than the sister ministry was doing. But how does the situation stand now? Over the last five years, the increase in the volume of construction and assembly projects was 22.8 percent compared to the previous five years. At present, the growth rate is 4.5 percent annually. In this period of time, however, the technical level of construction has improved considerably.

Every year, miners penetrated 10 to 12 meters deeper. A kilometer-deep shaft is not a rarity today. At the moment, the Donets coalfields hold the depth record: 1260 meters. And by all accounts, this is not the ultimate depth. In the miners' work, it is not difficult to imagine how much depends on who gives them access to the coal, sinks the shafts and provides the immense network of underground tunnels.

Has this dependence on the ministry's own efforts worked out as expected? I asked this question of the first deputy minister of the USSR Coal Ministry, V. Bely. "It depends on how you look at it," he replied. And he gave the figures appearing at the beginning of this article. "As you can see," he says, "we are not on schedule, we are developing...."

In this area, there is in fact strong experience, worthy of imitating, there are big names in construction, top-flight men responsible for construction projects worth millions every year. The USSR Council of Ministers Prize was awarded for the fast, high-quality construction of such a modern mine as the Vorgashorsky. And there are the famous "millionnaire" brigades: I. Draskov, A. Platonov, N. Sergeyev--these are the ones to reckon with.

But other facts and figures can be given, indicators which force one to look at the matter differently from the ministry's position. In its ten years of independent effort, this area has never once met the State plan for mine construction. It is true that construction and assembly projects are growing,

but at one-third the level planned. The technical level is improving, but even so, labor productivity is noticeably lagging behind technical progress. As a result, coal production capabilities are being thrown off schedule more often than they are met. In short, construction is not providing the required level of development for the coal industry. It is falling behind energy program goals.

Why are construction entities in this area working below their capacities? Deputy Minister Bely gave three basic reasons: insufficient capital investment in new construction, insufficient personnel and insufficient equipment provisions in the plan. As we can see, all these reasons are purely external, as if coal industry leaders are blameless: "Work corresponds to the manner of supply," he said.

However, it is difficult to agree with this formulation of the question. In order to examine the matter more broadly, let us come down to earth from this bureaucratic ivory tower. No, the government did not short coal producers on basic needs: capital investment in this area is increasing from year to year. But is far from being properly utilized. This year, the situation has even worsened. It is hardly worth bringing up a shortage of funds when year after year priority projects, for which resources are specially earmarked, lag behind schedule and some mines, for example, the Dolinskiy Mine on Sakhalin Island and the Udarnovskiy Mine in the same vicinity have been in the process of reconstruction for 20 years and work quality not unfrequently receives scathing criticism. The Kuznetsk coalfields are particularly instructive: more than a few examples of lengthy construction can be mentioned there.

What do ministry officials do to straighten out the situation? Every year there are two or three meetings on the subject, and deadlines and quality are discussed. Orders are issued, but much of their contents is left unrealized. Deputy Ministers V. Bely and E. Polak recently made a trip to the Kuznets Basin, where a particularly acute situation had developed, but no particular progress has been noted. Instead, the situation is growing worse.

Here are some construction rates: The Kuzbasshakhstroy Combine, whose scope of operations includes the entire region, is fulfilling about 70+ percent of the plan. It is here where the greatest shortcoming in the work of the USSR Coal Ministry is the most evident: capital investment is spread too thin. At present, this combine is performing operations at 233 construction sites involving 1,480 projects. It turns out that an average of 8 men is working at each project. It is not surprising that the construction backlog increased by 36 percent in the last three years. There is only way way out: remove the really small projects from the combine's responsibility and concentrate efforts on new construction and large reconstruction projects. A resolution by the CPSU Central Committee and the USSR Council of Ministers on the improvement of planning and the control of capital construction, published 27 May, 1984, is directed at this very point. All other projects should be built economically by the mines and unions themselves. Also, in view of the 500-kilometer-long basin, perhaps a restructuring of Kuzbassshakhstroy should be considered for the purposes of eliminating much of this giant's complexity and many of its offices.

Thus, there is complaining about the shortage of funds on one hand, and the inefficient use of thinly spread funds on the other. But this is not all. A construction worker without a strong construction infrastructure, i.e., without plates, panels and reinforced concrete, is like a shoemaker without shoes. This is the second grave reason for this area's lagging. However paradoxical it may be, it is a fact that materials earmarked for the development of a materials base are not being produced--the infrastructure construction and assembly plan is only being 60 to 70 percent fulfilled. And this is the average. There are also record breakers: for example, the Tomusinskiy Plant, which makes large prefab building panels, met 29 percent of its plan in an eight-month period and the Leninsk-Kuznetskiy Plant managed 12 percent. Yet both were high-priority targets this year. In addition, basic facilities supporting the construction industry are not only being slowly built, they are shabbily run. Many such facts could be mentioned.

Since we've brought up the subject of "a shoemaker without shoes," then unfortunately, construction workers frequently find themselves not only without reinforced concrete, but also without a roof over their heads, child-care facilities or schools. Construction of living quarters, basic social and cultural facilities and stores lags considerably behind industrial construction, as if they were the caboose of the train. Failure to appreciate these vital facilities is clearly chronic at the USSR Coal Ministry. This has led to great difficulties in developing personnel and a large turnover. In this situation, to talk about a personnel shortage and claim it as a purely objective excuse is to close one's eyes to the actual state of affairs. How many problems there were in building the Yuzhno-Yakutskiy Coal Complex! It was about 400 kilometers from the nearest railroad, the climate was severe, and a large construction project had to be done quickly. At the beginning, quite a few errors were made, but they were tolerable. But the basic turning point in the course of construction came when special attention was given to the base, living quarters, social and cultural facilities and stores. The construction and rapid completion of the living quarters complex played an important role and in fact made the difference in the fate of the complex. Personnel problems ceased to be so urgent and the beautiful, modern city of Neryungri grew up. And here is now the KATEK [Kansk-Achinsk Energy Complex] started: a huge, promising construction project with a railroad nearby and conditions unlike those in Yakutsk. However, error took root deeply here. The production base, living quarters, social and cultural facilities and stores were relegated to second priority. By the way, the USSR Ministry of Energy was in charge of both these construction projects. Inattention to such important matters always leads to an acute personnel shortage.

And the most acute personnel shortage is always in the Kuzbass. This is where the concern about developing personnel should be of paramount concern. But it is precisely here where living quarters are being built so wretchedly. The Kuzbasszhilstroy Combine, headed by G. Chernykh, is meeting only 65 percent of the plan.

One must not fail to mention that of the 77 mines in the Kuzbass, 30 producing coal for power generation could be operating with the more economical open-pit method. There are mines with very low labor productivity: 25 to 30

metric tons per worker per month. In highly productive pits, however, productivity reaches 500 metric tons. Now to discuss the equipment shortage, about which so many complaints are heard in the USSR Coal Ministry. I took this question to the USSR State Planning Office.

"Yes, there are shortages," agrees V. Pushkanov, assistant head of the Coal Industry Department. "Basically, it is a matter of heavy bulldozers, but unfortunately, they are currently a problem for many areas. From my position, I cannot consider the miners' policy on materials and equipment totally correct. In this ministry, more often than not, production tonnage receives first priority, and mine construction gets second priority. When the miners defend their requests for resources at the State Planning Office, they present production needs and construction needs separately. And when they get them, they divert a portion of these resources from the first to the second, which, it goes without saying, is basically improper. With that approach, construction is left in second place, which is like crawling out on a limb and sawing it off behind you."

One must still add that mine construction equipment is being utilized at less than capacity. A contradiction arises here: the level of mechanization is growing, but production by individual working methods is declining. Excavators, tractors equipped with high-angle excavating equipment and many other types of machinery are poorly used. And there is something else in addition for the experts at the USSR State Planning Office to think about: the Coal Ministry is provided with poorer equipment than the general construction ministries.

But in general, the Ministry still has many levers which it can pull to speed up delayed construction. Among them are the improvement of planning, which often leaves something to be desired; the organization of the production of construction supplies, where there are also many weak areas; and improved design. The urgent challenge in mine construction is the proper utilization of these resources.

8844
CSO: 1822/102

COAL

BRIEFS

PODMOSKOVNAYA MINE PRODUCTION UP--Novomoskovsk, Tula Oblast, 9 [Nov]--The miners of the Podmoskovnaya Mine have produced a half million tons of coal since the beginning of the year. The largest mine in the oblast has long had a reputation as an academy of innovative experience. The watch dedicated to the 50th anniversary of the Stakhanovite Movement is showing that this year a third section of the Podmoskovnaya Mine will produce over 500,000 tons of coal per year. This section is worked by the collective of Yuriy Yamov. [Excerpts] [By V. Shvetsov, PRAVDA correspondent] [Moscow PRAVDA in Russian 10 Nov 84 p 1] 12595

GIDROUGOL' PRODUCTION PROBLEMS--A significant part of the coal production shortfall for the USSR Ministry of the Coal Industry will be the responsibility of the Novokuznetsk miners: this year, they are over a million tons short in production, fulfilling their plan tasks by only 80-82 percent. The Yubileynaya, Nagornaya, Krasnogorskaya, and Inskaya mines are in a particularly difficult position. They leave much to be desired in the areas of mine work organization, equipment use and personnel problems. All of the enterprises in the Gidrougol' Association (A. Gontov, director) are lagging in their coal face development work. The development miners work at an unsteady pace, particularly in coal-face and auxiliary workings. They are 15 km behind their plan since the beginning of the year. The development of two faces in the Inskaya Mine is behind schedule, and production is being slowly restored after the accident at the Yubileynaya Mine. The basic mine field of the Nagornaya Mine is in need of improvements. [Text] [Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 17 Nov 84 p 2] 12595

FIVE-YEAR PLAN FULFILLED--Dimitrov, Donetsk Oblast--The largest mine in the Donbass, the Imeni A. Stakhanov Mine, has entered the next five-year plan. The mine dispatcher entered the largest daily output--8,700 tons--into his logbook. This amount put them above the level planned for the end of 1985. The enterprise continues to increase its output. New shafts are being sunk, underground main passageways are being driven and future coal faces are being developed. As they are put into production, the mine's annual production will reach 4 million tons, which is enough to supply four large all-union coal consumers. [Excerpts] [Moscow SEL'SKAYA ZHIZN' in Russian 30 Sep 84 p 1] 12595

ZYRYANOVSKAYA MINE BRIGADE OUTPUT--Novokuznetsk--The brigade of Hero of Socialist Labor M. Reshetnikov, at the Zyryanovskaya Mine, achieves results that few other coal enterprises have achieved. Since the beginning of the five-year plan, this leading collective has produced over 5 million tons of coal, including 330,000 tons above plan. Over 126,000 rubles have been saved as a result of reduced fuel costs. A new labor victory has recently been achieved: a million tons of coal have been produced since the beginning of the year. This plateau was reached two months earlier than specified in the annual socialist obligations. Labor productivity reached 1,000 tons per worker per month. [Excerpts] [By V. Bobrov, SOTSIALISTICHESKAYA INDUSTRIYA correspondent] [Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 11 Sep 84 p 1] 12595

STAKHANOV MINE SUCCESSFUL--Krasnoarmeysk, Donetsk Oblast--The workers of the imeni Stakhanov Mine yesterday reported that they had fulfilled their annual obligations. Since the beginning of the year, the collective of the largest coal enterprise in the Donbass has shipped 115,000 tons of coal above plan to the nation's factories and power stations. By skillfully using the capabilities of complex mechanization, the miners are almost two years ahead of schedule in bringing the enterprise up to full production. The miners are producing an average of 870 tons of coal per day from one coal face, which is twice the average for the entire basin. [Text] [Moscow SEL'SKAYA ZHIZN' in Russian 25 Oct 84 p 1] 12595

LUZANOVSKIY MINE PRODUCTION BEGINS--The miners of the new Luzanovskiy Surface Mine have produced their first tons of coal. When the mine reaches full capacity, it will completely satisfy the solid-fuel demands in the Primorye area. [Text] [Moscow EKONOMICHESKAYA GAZETA in Russian No 38, Sep 84 p 3] 12595

NEW ENTRY-DRIVING MACHINE--Donetsk--Right after the close of the "Coal 83" international exhibition in Donetsk, the powerful ChPP-5 entry-driving machine was shipped to the new Yuzhno-Donbasskaya No 3 mine. The machine is designed for large-cross-section horizontal workings. The brigade of Vladimir Ivanovich Titov, of the sixth mine-construction administration, became custodians of the new machine. The brigade used the machine in rocks of varying strength, including some of rather high strength. The machine had the highest average monthly productivity: 120 linear meters of 22-square-meter crosscutting. However, the machine is capable of larger excavations, up to 35 square meters. The new machine is equipped with special automation equipment developed by the Avtomatgormash Scientific-Production Association. In addition, the machine has an automatic load regulator. The interdepartmental commission recently reviewed the machine's tests results and gave it high marks. The machine was reliable and had good productivity. At the same time, a number of suggestions for design improvements were made. These suggestions will be taken into account by the Yasinovataya Machine Building Plant when they begin series production of the ChPP-5 next year. [Text] [By L. Gurevich] [Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 7 Oct 84 p 2] 12595

CENTRAL ASIAN PRODUCTION RECORD--A coal production record for the Central Asian republics was set under difficult geological conditions by the miners

of the Kok-Yangak Mine in Southern Kirghizia. The brigade of E. Murzakhmatov, using a mechanized mining system, produced 1,059 tons of coal in a 24-hour period. [Text] [Moscow EKONOMICHESKAYA GAZETA in Russian No 44, Oct 84 p 2] 12595

BEREZOVSKIY-1 MINE PREPARATIONS--The machine builders of the Zhdanovtyazhmash have built giant rotary excavators capable of handling 5,250 cubic meters of rock per hour for the Berezovskiy-1 Surface Mine. The mine, now under construction, will be the largest surface coal mine in the country. The Ukrainian machine builders have completed ahead of schedule their part of the agreement on creative cooperation with the Siberian designers of KATEK [Kansk-Achinsk Fuel-Energy Complex]. In turn the Sibtekhmontazh Trust in Krasnoyarsk has organized a special administration in the village of Dubinino and has promised to complete the installation of two excavators in the fourth quarter of next year. "While the installation went well in the first few days after the agreement was signed," says K. Bem, director of the surface mines under construction, "now that winter is near, the Sibtekhmontazh Administration (A. Nevzorov, director) has cut back their pace. Really, the efforts have to be tripled in order to bring the mine up to capacity on schedule." [Text] [Moscow EKONOMICHESKAYA GAZETA in Russian No 44, Oct 84 p 17] 12595

PRODUCTION INNOVATIONS EXHIBITED--Four sections of an exhibition show the experience of the best enterprises in the USSR Ministry of the Coal Industry in preventing coal losses during mining and transport and in saving material resources during the development and production of mining equipment. The Voroshilovgradugol' Production Association is demonstrating its "Gornyak" vacuum filter for dewatering floatation concentrates. This unit, besides reducing the coal moisture content, greatly reduces the energy consumed during coal production. The collectives of the Rostovugol' and Vorkutaugol' production associations and the Miner's Light Machine Building Plant in Kharkov are sharing their experience in implementing high-efficiency technologies and labor methods. The work will be completed in January 1985. [Text] [Moscow EKONOMICHESKAYA GAZETA in Russian No 41, Oct 84 p 24] 12595

ABAYSKAYA MINE PRODUCTION--Abay, Karaganda Oblast--The last tons of coal in the 1984 obligation of the Abayskaya Mine's No 6 Section were produced underground by the link headed by Ya. Verenga. The Abayskaya Mine's No 6 section, managed by D. Bolotin, has been among the leaders since the beginning of the five-year plan. The underground miners have produced over two million tons of coal, over 300,000 tons of which were above plan. [Excerpts] [By N. Belov, KAZAKHSTANSKAYA PRAVDA correspondent] [Alma-Ata KAZAKHSTANSKAYA PRAVDA 30 Oct 84 p 1] 12595

CSO: 1822/89

EXPLOSION-PROOF LIGHTING SYSTEM IMPLEMENTED IN OIL INDUSTRY

Alma-AtaKAZAKHSTANSKAYA PRAVDA in Russian 24 Oct 84 p 3

[KAZTAG article, author not specified: "Sunlight by Pipeline"]

[Text] It is now brighter in the shops of Mangyshlak petroleum pumping stations, although electricity consumption has decreased to a fourth of its former level. Workplaces are evenly illuminated by means of perforated light conduits.

Lamps must burn round the clock alongside the powerful pumps which feed the trunk oil pipeline with flammable crude oil. But, recognizing this fact, safety regulations demand that at the same time all electrical fixtures should be fully protected against the danger of explosion. It was necessary to spend additional money on metal-clad cables and heavy-duty insulation for lamps, and all the same no one could fully guarantee fire safety.

At the request of the Mangyshalak workers, specialists from the Ukrainian Tyazhpromelektroproyekt Institute studied the problem. They proposed locating the light source outside the building and "transmitting" its rays through a polyethylene pipeline with a mirrored interior surface. Through special perforations in the conduit the machine room is filled with a soft diffused light. Each fluorescent lamp, the spectrum of which is close to that of natural sunlight, replaced tens of ordinary incandescent ones. This made it possible to save 16,000 rubles worth of electricity annually.

Having outfitted all petroleum pumping stations with the light "conveyors," the innovators decided to make use of free lighting at the same time. A pilot project is being developed upon which the sun's rays will be focused during daylight hours.

12825
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ALTERNATE FUELS

TURKMEN CONFERENCE ON SOLAR ENERGY, DESERT PHYSIOLOGY

Ashkhabad TURKMENSKAYA ISKRA in Russian 24 Nov 84 p 2

[TurkmenINFORM article, author not specified: "Solving Problems Together"]

[Text] The use of solar energy in the national economy and the adaptation of human beings to the conditions of a hot climate are highly important challenges being addressed by scientists of the Central Asian republics and Kazakhstan.

At the regional conference of chief scientific secretaries of the Presidiums of the Academies of Sciences of the Central Asian republics and Kazakhstan, held on 21 November at the Turkmen Academy of Sciences, discussion centered on how best to conduct research along these basic scientific lines and what must be done to coordinate work in order to unify efforts toward solving very important economic problems.

The conference was opened by A. G. Babayev, corresponding member of the USSR Academy of Sciences and president of the TuSSR Academy of Sciences.

N. S. Pshirkov, deputy chairman of the USSR Academy of Sciences Presidium Council for the coordination of scientific work among Academies of Sciences in the union republics, spoke of the goals and tasks of the conference.

Reports concerning the progress of research on the utilization of solar energy in the national economy were given by R. Bayramov, general director of the TuSSR Academy of Sciences Solntse [Sun] Scientific Production Association and academician of the TuSSR Academy of Sciences, S. A. Azimov, academician of the UzSSR Academy of Sciences, and Z. K. Kabilov, head of the solar energy technology laboratory at the TaSSR Academy of Sciences Institute of Physics and Technology.

In their reports F. F. Sultanov, academician of the TuSSR Academy of Sciences, and Z. T. Tursunov, director of the UzSSR Academy of Sciences Institute of Physiology and doctor of biological sciences, told of the achievements of scientists from the republics of the region in dealing with the problem of adapting human beings to the natural conditions of desert areas. Conference participants exchanged opinions on the topics under discussion and outlined ways to cooperate in the solution of problems common to all parts of the region, with the goal of introducing scientific developments into the national economy as quickly as possible.

12825
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ALTERNATE FUELS

GEOTHERMAL ENERGY RESEARCH IN SOVIET FAR EAST, CAUCASUS

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 3 Oct 84 p 4

[Article: "Utilizing the Earth's Heat"]

[Text] Heat from the Earth's interior and heated subsurface water are considered to be promising energy sources. What is being done in our country to speed up their utilization on a broad scale?

N. Zakharov
Yakutsk

At the request of our correspondent this question is being answered by G. Shasharin, the USSR deputy minister of power and electrification:

The question of the utilization of geothermal water and the Earth's internal heat is not a new one. But until recently the technology which would allow this so generous gift of nature to be utilized on a commercial scale was not available. Now a certain amount of experience has already been accumulated, indicating not only the theoretical possibilities but also the practicality of the utilization of geothermal energy sources. The Pauzhetka hydrothermal steam electric power station, built in Kamchatka as early as 1967, can serve as an example of this. By today's standards its capacity, 11 megawatts, is relatively small. It is cost-effective. And in its technical and economic indicators it surpasses an electric power station of comparable capacity using fuel which must be shipped from another location and is therefore expensive.

Construction has begun on another and this time more powerful geothermal electric power station, the Muntovskaya. Its projected energy output is 200 megawatts. The first phase, with a 50 megawatt capacity, is planned to go into operation during the next five-year plan.

One should add that this is only the beginning of geothermal energy development in Kamchatka. According to geological and geothermal projections, it would be possible to construct several stations with a total capacity of 2,000 megawatts in this region in the not so distant future. But other zones of active volcanism--Sakhalin and the Kuril Islands--are also rich in

commercial-scale resources of geothermal steam and steam-and-water mixture. Here, too, geothermal electric power stations could be built in the future.

Lately so-called thermally anomalous zones have attracted the attention of scientists and specialists. Here, at a depth of up to 4 or 5 kilometers, water-saturated strata are heated to a temperature of 150-200° C. It is very tempting to utilize this source of energy. All the more so since the capacity of power stations which could be built in our country on the basis of thermal zones is estimated at 150,000 megawatts. Roughly half of this capacity falls within the territory of the European portion of the USSR and especially its southern part: the northern Caucasus, the Crimea, Armenia and Transcaucasus.

However, problems related to the extraction of surface heat have not turned out to be easy ones. A series of the most complex technical tasks have confronted scientists and engineers. These include problems in the creation of so-called underground circulating systems. Such systems must be equipped with two groups of wells. In one of them, the pressure system, water is pumped in and gathers heat from porous rock layers as it penetrates them. In the other system, the production wells, the heated water returns to the surface, where it releases its heat as steam. The steam is fed in to turbines and is used to produce electrical energy. In the long term, such experimental and industrial-scale energy installations that utilize similar underground circulating systems will be created.

At the present time three experimental installations are already under construction: the Kayasulinskaya in Stavropol, the Tarumovskaya in the Dagestan ASSR, and the Mukachevskaya in Transcaucasus. These regions were selected in such a manner as to test the working of various types of systems under differing mining and geologic conditions. Only when sufficient experimental data has been accumulated at these small pilot installations (with a capacity of up to 10 megawatts) will they be replaced by a new generation of large-scale systems, capable of competing with traditional electric power stations.

It is appropriate to note that the Scientific Research Institute for Energy Sciences imeni G. M. Krzhizhanovskiy (ENIN), together with planning organizations of USSR Minenergo [Ministry of Power and Electrification] has done a great deal toward the successful conducting of the tests: plans are complete, necessary materials have been collected and the equipment is ready. The delay now results chiefly from the process of well drilling, which is supposed to be carried out by organizations of the Ministry of the Gas Industry. The new Soyuzburgeotermiya Production Association was organized in that ministry two years ago. It was entrusted with leading organizational functions with regard to the accessing and utilization of plutonic heat. This would speed up the completion of well drilling efforts.

Although the first pilot geothermal installations with underground circulating systems have not yet been built, the work of scientists in this field goes on: research is being done on equipment protection and on types of energy hardware. Recently a new type of installation has been under development at ENIN, using a combination of geothermal energy and conventional fuel. In these, fuel would be added only during periods of peak load on the energy

system. Natural methane gas, found dissolved in geothermal water, could be used for this purpose. In individual fields, up to seven cubic meters of methane gas occur per one cubic meter of water. Economic indicators for dual-capability geothermal power stations will be more favorable than those utilizing "pure" geothermal energy.

12825
CSO: 1822/106

ALTERNATE FUELS

SOLAR POWER STATION IN CRIMEA

Kiev RADYANS'KA UKRAYINA in Ukrainian 20 Sep 84 p 2

[Article, published under the heading "Called on the Road by a Letter," by RADYANS'KA UKRAYINA correspondent E. Dubovyk and engineer V. Yatsemyrs'kyy, Leninskiy Rayon, Crimean Oblast: "Glow of An Imaginary Fire: Why Construction on the First Solar Electric Power Station Is Proceeding So Slowly"]

[Text] One evening an alarm sounded through the streets of the village of Shcholkine: there was a fire at the construction site of the solar power plant! From the hill at the edge of the power plant construction worker settlement one could indeed see a glow above Aktash Lake, on the shore of which a solar electric power station is under construction. It spread, grew, and soon the fiery glow filled half the sky. But when the firemen and the many volunteers reached the construction site, they found there only a small bonfire around which the watchmen were warming themselves. But the fire had been built close to a solar reflector panel, with its mirrored surface of 25 square meters. The appearance of the enormous glow had been caused by the mirror's reflection of the light from the little fire.

This incident or, more precisely, the very principle of apparent effect being at variance with the actual state of affairs, was recalled when we visited the construction site of SES-5 (a 5-megawatt solar electric power station), being built in the Crimea. We were there in response to a letter from construction workers and volunteer inspectors N. Gerasimov, Yu. Korshunov, V. Bondarenko, and others, who were concerned about deficiencies and errors of omission on this construction project, where the Soviet Union's first solar electric power plant is being born.

SES-5 is being erected on the Kerch Peninsula, next to the Crimean Nuclear Power Plant. Upon learning that the solar electric power station will be generating hundreds of times less electric power than its neighbor, the nuclear plant, one might wonder why they are being sited side by side. And is such duplication advisable? The people at the State Power Engineering Institute imeni G. M. Krzhizhanovskiy, which is handling scientific oversight of the project, gave the following reply to this question in an article published in RADYANS'KA UKRAYINA.

Feeding its kilowatts into the peninsula's power grid, the SES will serve as a scientific proving ground for developing the technologies of mighty power generating plants of the future. Sunlight will supply the "fuel" for them. The Crimea attracted the solar power engineers due to the intensity of its solar radiation and the exceptional transparency of the atmosphere, while the Kerch Peninsula was attractive by the fact of its rocky and alkali soil, which is unsuited to agriculture. And this factor is far from secondary importance. An SES requires considerable area for deploying its solar reflectors, which provide the thermal energy. In addition, it is much more advantageous to build a solar power generating plant not on an "empty" site but where a substantial construction base, roads and service lines have already been established, where there is manpower, housing, amassed experience, etc. And both facilities are operated by the same agency -- the Ministry of Power and Electrification.

Construction of a solar power generating plant is a government activity of exceptional importance. Considerable money has been allocated for development of this pioneer facility. Highly reputable construction trusts, and all-union and republic-level administrations are involved in the project. The decorated Dneprostroy Administration, which is also handling contruction of the Crimean Nuclear Power Generating Plant, is the project general contractor.

Everything has been placed on a solid foundation, and it would seem that everything has been taken into account. As the letter reports, however, to date, in the fourth year of construction, only one fourth of capital allocations for SES-5 has actually been spent. The construction targets, although adjusted downward practically every month, have only been three fourths met in the last two and a half years. What is the problem?

Putting this question to V. Dubovenko, who is in charge of the plant under construction, we were expecting to hear what would seem to be inevitable references to the pioneering nature of the project and objective difficulties connected with this fact. He did in fact mention these things, but he began with a frank and unequivocal critical appraisal of the performance of the general contractor, the Dneprostroy Administration, and its Crimean subdivision.

This pioneer solar power generating facility is to come on-line next year. But startup is scheduled for the fourth quarter of the year, surely by virtue of inertia. But to start up the plant in the fall, when the sun is "working" at half power even in the Crimea, means preventing the scientists from immediately work-loading the equipment to full output. Precisely for this reason the combined brigade headed by O. Kuznetsov -- the nucleus of general contractor Section No 4 of the construction administration, proposed completing work on the solar power generating plant ahead of schedule and adopted corresponding pledges. The workforces of many subcontractor organizations have swung their support behind this initiative.

We must acknowledge that the crews are doing everything in their power to make station startup day as soon as possible. And it is a pity that the workers' enthusiasm is not being bolstered by engineering support.

If one attends a meeting of the construction headquarters staff or reads the minutes of a planning session, one sees that plenty of promises are made at these meetings, assurances, and guarantees; they are emphatically "taking up the slack in the work schedule," etc. But very little heat is generated by the "fire" of these meetings, and the impassioned enthusiasm is more a simulation than an actual sign of businesslike activity. There are many evidences of this. There are six principal facilities at the SES construction site. But work has not been concluded on a single one of these. That is hard to believe, but it is true -- not a single one.

In their letter the volunteer inspectors posed the question point-blank: why is nobody making the guilty parties answerable for the delay in progress on a project of great national significance? An attempt to "call to account" was made at a meeting of the construction project party committee, the letter stated. But a very timid attempt. The party committee limited itself to discussion of local problems. And the party committee resolution did not produce any significant changes. From there, from the construction site, it is difficult to "get to" the principal guilty parties, the authors write.

FIrst of all, about the party committee resolution. Unfortunately it pertained only to a small number of items and, in addition, in its approach to the problems it was rather divorced from the practical business of production. The committee ignored such an important problem as the responsibility of party members for an assigned task, although there are persons who should be called to account and things for which to call them to account. For example, P. Skrypnyk, deputy chief of the construction administration of the Crimean Nuclear Power Generating Plant -- for supply miscalculations, and A. Bulava, head of the production department -- for a passive attitude and lack of demandingness, and chief engineer Ye. Chernyakhovskyy -- for failure to exercise regular and consistent oversight over the situation at the SES.

Then there are the officials named in the letter as the "principal guilty parties." The letter names B. Kuz'menko, head of the Dneprostroy Administration, chief engineer A. Zabara, and the heads of a number of administration services involved in construction of the solar power generating plant on the Kerch Peninsula. A good many complaints against them have piled up at the construction site, most of which are quite justified. We feel that the board of the republic Ministry of Power and Electrification should appraise the "contribution" of each to chronic failure to meet targets on this important construction project and should help get construction moving on schedule.

The expression "get to" in the letter has dual significance, first and foremost purely geographic, for the Dneprostroy Adminsitration is located in Zaporozh'ye, and its officials pay only brief visits to the solar facility construction site. These visits most frequently involve nothing but participation in planning sessions and other meetings.

It is also clearly high time for local party bodies to receive an accountability report from the Dneprostroy party member-officials and properly to appraise the management performance on this construction project, which unfortunately is characterized by superficiality, a lack of demandingness, and excessive attention to form with detriment to content. There is an urgent need for this, for to date there has been more apparant than actual flame at this solar power generating plant construction site.

3024
CSO: 1811/5

NON-NUCLEAR POWER

ZAGORSKAYA PUMPED STORAGE PLANT UNDER CONSTRUCTION

Leningrad LENINGRADSKAYA PRAVDA in Russian 16 Sep 84 p 1

[Article by A. Perevoshchkov, APN [Novosti Press Agency] correspondent: "Zagorskaya GAES Under Construction", in column "How Wide Is My Country"]

[Text] Our country's first commercial pumped storage hydroelectric plant (GAES), with a capacity of 1.2 million kW, is being built at the city of Zagorsk near Moscow. An experimental station of this type is already in operation in Kiev. The Zagorskaya GAES will be a test ground for developing plans for a future GAES in the European part of the country.

GAES's have a special role in the USSR Energy Program up to the year 2000. The increase in electrical energy production in the European part of the country is planned primarily through atomic power stations (AES). Their optimal operating condition is an even load throughout the day. In practice, however, requirements for electrical energy in this region change throughout the day. GAES's will permit the most effective adjustment to this unevenness. During the peak hours, the GAES operates as an ordinary hydroelectric station, the only difference being that the water does not flow out into a river channel, but is accumulated in the so called lower reservoir. At night the GAES, obtaining excess electric power from all AES's, pumps the water from the lower reservoir to the upper and prepares fror the night cycle. Specialists estimate that GAES capacity in the European part of the country should amount to about 20 percent of total nuclear power station capacity in this region.

What are the parameters for the Zagorskaya GAES? Reservoir: lower -- 33 million cubic meters, upper -- 30 million. Difference in reservoir level -- 100 meters. The Zagorskaya GAES will have six units with a capacity of 200,000 kW each. The penstock will be 740 meters long and 7.5 meters in diameter. All equipment installed in the station is produced domestically.

Vladimir Plotnikov, the project chief, said, "the selection of this site in the flat part of the country is no accident."

"We were guided by two considerations, the natural gradient and the possibility of making maximum use of local construction materials (a sand and gravel quarry is not far from the construction site). In addition, a railroad

line and highway are nearby and it is only necessary to build about 60 kilometers of transmission lines to hook up the GAES to the Moscow energy system."

The penstock pipe is assembled from large cross section ferroconcrete components manufactured at the site. To the traditional steel pipe we added a concrete surfacing which improves the structure's reliability. In assembling the pipe, we use a powerful winch which permits working on steep slopes at any angle.

So-called small crushed stone concrete is used in the construction of the Zagorskaya GAES. In the ordinary method of preparing concrete mix, small stones are removed. We use small gravel as a dispersion aggregate. This will give the concrete the necessary strength and frost resistance, which is especially important for the bases of the Zagorskaya GAES as the annual fluctuation in reservoir height amounts to 9 meters. Thus, the concrete surfaces periodically exposed during the winter will be subject to the effects of low temperatures. The use of small gravel concrete not only improves the structure's frost resistance, but also reduces costs by several million rubles.

Original technology is used in the constsruction of the Zagorskaya GAES. With the "classical" work method, the ground is laid in several layers 40 centimeters thick and each layer is rolled down to complete compaction. At the Zagorskaya GAES, 6-7 meter layers of ground are tamped by a 15 ton machine over the entire thickness. This accelerates the work pace three fold and we save millions of cubic meters of ground as we are only removing a vegetative cover. Now a few words about the equipment at the GAES.

We are using units working in two modes: pumps and turbines. This new model hydraulic machinery has high quality and is sufficiently profitable. In addition, its use frees us from dependence upon foreign market conditions. The assumed payoff period for the station is five years.

11574
CSO: 1822/40

NON-NUCLEAR POWER

EKIBASTUZ PROBLEMS SURVEYED

Moscow PRAVDA in Russian 8 Aug 84 p 2

[Article by Yu. Razgulyayev, PRAVDA correspondent in Pavlodar Oblast: "Lessons of Ekibastuz. Economics: A Management Style"]

[Text] The construction of the Ekibastuz GRES-1, a thermal power engineering giant is close to complete. In its main building riggers are completing work on the assembly and setup of the 8th energy block. In a few weeks, it will "come to life" and the last 500,000 kW units will produce current. However, this blue two stacked "ship", rising on the shore of an artificial reservoir, is only the first unit of a huge power engineering "cascade" and one of four energy giants which will be built in the Irtysh Steppe. How is it working? What must be done so that the new power station will be built more rapidly and at less cost?

In the last days of July, the bulletin in the Administrative Service Building of Ekibastuz GRES1 had happy news. The brigade servicing the 7th energy block was a week ahead of schedule in fulfilling the monthly target and sent customers more than 250 million kWh of electric power. But even this high pressure work could not compensate for failures which have followed the Ekibastuz workers since the start of the year. I remember one from a meeting at the Dzhezkazgan Mining Metallurgical Combine.

It seemed that the usual shift for the electrolysis brigade led by V. Fomin, one of the best in the combine, had begun successfully. But they only started work when they got the command: "Restrict the consumption of electric power".

"Ekibastuz is shaky again." the brigade leader said sadly.

Later things got even worse: before their eyes the flow of electricity, one could say, weakened and dried up. The Dzezkazgan Mining Metallurgical Combine, with its dozens of shops and very complex production operations, was without power for some time.

The experienced metallurgist turned out to be right. Although his town is several hundred kilometers from the fuel and energy complex, it was a

disruption in the operation of the EK GRES1 that hindered the combine's operation. Seven energy blocks in this station were operating at full power, but several units broke down. The chain of misfortunes rapidly reached other cities also.

The construction of the Ekibastuz Fuel and Energy Complex, where it is planned to build four stations of four million kWh each, considerably accelerated industrial development in central Kazakhstan. At the same time, however, the unforseen concentration of energy, and the huge unit capacity, made higher demands upon the reliability of all elements in the energy system and upon those whom it services. These have not yet been met.

It has become a common phrase to say that Ekibastuz GRES-1 is now the country's largest thermal power plant. Theoretically, yes, but actually? Of course, it isn't simple to reach the planned capacity of an energy block which is almost equivalent to Dneprogres [Dneprovskaya GES]. Also, it often uses coal with high -- up to 50 percent -- and extremely variable ash contents. This reflects on the stability of combustion processes, reduces productivity and influences the reliability of boilers. However, the first units have already been operating for three-four years. The time has come, as they say, to work honorably. The second block, for example, has been under repair for more than half of the calendar time. There has not been a quarter in which Ekibastuz GRES-1 has fulfilled the target. This year alone it failed to supply the country more than 1.5 billion kWh of electric power. More than half of the stoppages were the fault of power engineering workers themselves.

Of course, Ekibastuz workers have done much to develop industry in central Kazakhstan, to supply cheap electric power to enterprises in the Urals, Siberia and Central Asia. However, one cannot remain silent about the fact that the effect from these huge outlays are less than expected. Why?

I once attended a meeting of the general purpose brigade, led by V. Kurochkin. It is considered one of the station's best. Nevertheless, the shift leader's report was not so happy:

"As previously, electric power output did not exceed twothirds of the plan, there were overconsumptions of fuel and emergency stoppages..."

At almost the same time there was a problem with the fourth energy block. An operator failed to open a valve, another didn't move a lever, and the powerful machine froze. Is this negligence?

"It was negligence and inability to work," asserted A. Mokshin, GRES-1 Director. "First of all, we never have enough people and second, they have practically no training..."

In actuality, it has become common for the station to have almost a 1,000 vacancies. The shortage of workers is very acute and there can be practically no selectivity in such cases. They could train, but up until the end of last year the combine did not even have its own facilities for this. Specialists trained at other stations have scattered, one left, others have gone to work in various organizations. Local party organs could not affect this.

The situation is even worse with repair workers; they are only half staffed. It was even necessary to bring in people from Magadan to help the Ekibastuz power engineering workers.

In short, one of the main problems is cadre, their skills and responsiblities. However, at meetings of the project staff, the discussion is more frequently about blocks, turbines and pipes. The higher the rank of the representative from USSR or republic Minenergo [Ministry of Power and Electrification], who sits at the head of the table, the more categorical is the refusal to mention the collective's social and cultural needs. There is even a special term "watt-less projects", which are always on the back burner. These include, for example, the educational training center, the repairmachine plant, service facilities, housing, and social service and cultural facilities. It is sufficient to note that while the first station is almost complete, the construction of the repair plant only began last November.

True, the situation with housing is somewhat different. Even more has been built than was planned for the GRES1 , about 100,000 square meters have already been turned over to the second station, but there are still not enough apartments.

V. Temirbayev notes, "from the very beginning there were serious oversights in the plans for Ekibastuz. Designers used average norms, but our young city was clearly not included."

This is not all. It would seem that it was not a bad idea to attain the cheapest construction costs per kWh of power at Ekibastuz. However, this was attained by cutting repair and auxilliary operations and service facilities. For example, studies showed that Ekibastuzenergostroy [Ekibastuz Contstruction Trust] needed 6,000 people to install the station. More than twice as many people are now working here, but the block's introduction is lagging by two years.

This running after poorly thought-out economies and good-sounding start up reports costs large losses and not only material ones. USSR Minenergo has been repeatedly "burned", violating construction integrity. However, one still cannot be confident that such mistakes will not be repeated, in particular in the construction of the second Ekibastuz GRES-1.

The first blocks here must be started up during the current five-year plan. Judging from everything, the ministry is not seriously thinking about this. A new deadline -- 1986 -- is being worked out. However, even in this case it is essential to complete 80-100 million rubles worth of work annually and even more residential construction. E. Filatov, the head of Ekibastuzenergostroy, considers such a sharp jump unrealistic. It is difficult not to agree with him.

Take just the construction of the Trust's base. Everyone knows that it is this, and not orders and conversations, which determine the real productive force of a collective. In the very best years, the construction-installation work volume performed by our engineering builders on the station hardly

exceeded 50 million rubles. The plants for ferro-concrete products and metal structures and mechanisms, and cranes operated with solid loads. How can the work volume be increased 1.5-2 fold without increasing the base?

The power engineering workers themselves created this need to "jump over their heads". At Ekibastuz there are real possiblities for organizing highly active construction. The construction and installation of 30 "500,000 units" is concentrated in practically one spot. One can specialize the administration and organize their precise work and move from block to block. This is construction by the progressive flow line method.

The brigades of V. Pen'kov, B. Aralbayev and A. Kishchenko at the Sredazzenergomontazh [Central Asian Power Engineering Installation] Trust's Ekibastuz administration was the first to master this method. In recent years, they have increased labor productivity in boiler assembly twofold and now assemble multi-ton units in less than six months. In December, they asssembled the last, eighth boiler, as usual, ahead of time and with high quality. There is not even a column at the main building in the second station where installers were supposed to convert to the flow line method.

However, this is only one break in a flow which is well planned on paper. Mechanics, electricians, turbine assemblers are also in a critical situation. They are all experienced specialists who have had difficult periods during the origin of the collective and its "steeping" in a spirit for the project, which has become "their own". Now all their plans are hanging in the air because a work front has not been prepared for GRES-2. There is actually a threat to the many thousand strong collective of builders which was put together for this great project with such difficulty.

Scientists and practical workers are now more frequently citing Ekibastuz as a model for future fuel and energy complexes. Incidentally, it is not only for future ones. Many technical and organizational decisions which were verified in Kazakhstan are already being used at KATEK [Kansk-Achinsk Fuel and Energy Complex]. Again, questions arise about the lessons learned at this project. They have not been given their share of attention. At different times, several deputy ministers from USSR Minenergo were its direct curators. Resources for Ekibastuz were allocated to an "isolated project". Nevertheless, as has already been stated, the volume of uncompleted work still grows.

This means that management thinking was not on top of everything. A traditional approach, as they say, gathering together one's forces and breaking through, is not suitable to such a large project. New concepts, which should be based upon precise work rhythms, on balanced resources and high responsiblity for the work, have not been developed. At least such an approach has not been noticeable in actions.

There is an even greater felt need for this. The creation of large national economic complexes requires well balanced efforts on the part of many sectors, not only the builders themselves. It is intolerable here to have arbitrary methods by management, and the neglect of social problems. Using methods in the modern science of management, one can correct the oversights allowed. The ETEK [Ekibastuz Fuel and Energy Complex] and sector staff specialists have all the possibilities for this.

11574
CSO: 1822/40

NON-NUCLEAR POWER

GASIFICATION OF URBAN AREAS

Moscow EKONOMICHESKAYA GAZETA in Russian No 36, Sep 84 p 16

[Article by V. Varvarskiy, director, VNIPIenergoprom [All Union Scientific Research and Design Institute for Power Engineering] and E. Sarnatskiy, deputy chairman Gosgrazhdanstroy [State Committee for Civil Construction and Architecture]: "Heating of Our Apartments. The Energy Program at Work"]

[Text] In the next decade we will start to widely use nuclear fuel to produce thermal energy. This is of concern for the future, but now the efforts of scientists and designers should be directed towards improving the efficiency in the construction and operation of heat sources using organic fuel.

Up to 90 percent of our country's population lives in climatic zones where the average January temperature is below -15 degrees C. Winters here are usually long and severe. More than 600 million tons* of coal, gas and mazut are annually burned to obtain thermal energy necessary for space heating and ventilating and for industry's needs.

More than one half of the national economy's entire consumption of thermal energy is now supplied centrally -- from powerful thermal electric centrals (TETs) and large boilers.

TETs simultaneously produce thermal and electrical energy. While an ordinary thermal condensation electric station, producing only electrical energy, consumes an average of 356 grams of fuel per kilowatt hour, at a TETs, the figure is only 265 grams.

The first TETs began operation in Leningrad 60 years ago. Now there are more than 900, producing almost 30 percent of electrical energy and about the same share of thermal energy. Thanks to this, our power engineering burns 300 million tons of coal less per year in the production of electrical energy.

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* Here and elsewhere, fuel consumption is shown in arbitrary calculation (7,000 kilocalories in 1 kg of conventional fuel.)

The savings could be even greater. This depends directly upon the time and quality of heat pipe laying. In order to supply heat to an ordinary residential region in a city it is necessary to lay 150-200 kilometers of heat pipe. Frequently various sections are built by individual organizations at a time convenient for them. The coordination of all pipe laying is at times very difficult. All this leads to lack of coordination in the introduction of new buildings and projects, delays in attaching them to heat pipes which have already been laid from TETs. There are often cases where new small "dwarf" boilers not forseen by plans are built.

In 1983, a procedure was established under which not a single boiler can be built in a city without a special authorization from the organization responsible for determining the long term development of the central heat supply system. For cities with a population of 100,000, this is the VNIPIenergoprom Institute of USSR Minenerego [Ministry of Power and Electrification]. For all remaining population centers, it is institutions determined by the councils of ministers of the union republics.

TETs do not only save fuel in the production of electrical energy. Their introduction reduces service personnel (compared with small boilers) by 5-7 fold, increases labor productivity 8-10 fold. Environmental pollution is reduced and there are considerable improvements in the reliability of electricity supplied to cities. Therefore, the installation of TETs has been and remains the basic direction for the development of heat supplies to cities and industrial centers, both in the eastern and in the European regions of the country.

In addition it is possible, on the one hand, to reduce capital investments in the construction of TETs and, on the other, to improve the economies in their operation. This requires the construction of large steam boilers and the installation of counterpressure turbines in them. As a result, the TETs are simplified, as they say, to the limit.

Steam from the boilers, passing through the turbines and producing byproduct low cost (with regard to fuel expenditures) electrical energy, immediately passes into a heat exchanger where it heats water for heating cities and industrial complexes. It is thus no longer necessary to have condensers for turbines and complex water circulating systems. The amount of TETs built is reduced. Relative expenditure of fuel for such boilers per kilowatt hour is almost 100 grams less than an ordinary TETs.

The presence of such boiler TETs in the electrical energy system structure, however, creates definite difficulties in their operation. Such solutions cannot be used in all cases. The problem is that at boiler TETs, electrical energy can only be produced when heat is needed. Heat supply to users can be even throughout the day, but there are two distinct peaks in the consumption of electrical energy: in the morning and evening. Problems involving the creation of heat storage installations at boiler TETS, which could help them better work in the energy system, have still not been completely solved.

In addition to heat centrals and boiler TETs it is advisable to build large, so called peak boilers in cities. They are usually equiped with automatic

equipment and are automated. Working jointly with TETs in the winter, boilers produce thermal energy mainly during freezing days and in the summer are stopped altogether. Thanks to this TETs can be very economically completely loaded throughout the heating season and maximum use can be made of them in the summer.

A vivid example of implementing the principle of joint operation of TETs and boilers in a city can be seen in the central heat supply system in Minsk, where they have succeeded in achieving relative consumption of fuel for electrical energy produced at TETs which is one half of that at contemporary thermal condensation electric stations.

There are special energy units to cover peak daily electric loads and energy system loads. One of the most effective is the gas turbine, utilizing waste heat gasses through the installation of boiler-heat recovery systems. A VNIPIenergoprom has developed a design for such a peak block with a capacity of 45 MW and a heat production of 100 gigacalories per hour. A plan has been worked to utilize heat from a 100 MW turbine. A combined, so called steam gas installation, rated at 250 MW, is being installed at the Novotulskaya GRES.

The planning foundation of Soviet city construction and a scientific methodology for planning create the foundation for the effective development of cities' engineering infrastructure, including heat supply systems. These advantages should be boldly and completely utilized.

11574
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NON-NUCLEAR POWER

BRIEFS

FAST SCHEDULE--Irkutsk--The Zima-Balagansk LEP [Transmission line]-110 has gone into commercial operation. The new high voltage line will provide reliable supplies of electricity to remote villages in Nukutskiy, Ziminskiy and Ust'--Udinskiy rayons. Line installers from the East Siberian Electrical System Construction Trust turned the project over to rural workers almost four months ahead of schedule. The program outlined for the Angara region calls for the conversion of kolkhozes and sovkhozes to electrical heating in the immediate years ahead. The new line's introduction is a step towards this. [Text] [Moscow SEL'SKAYA ZHIZN' in Russian 18 Sep 84 p 1] 11574

NEW POWER PLANT--(Leningrad)--Brigades at the Kavkazenergomontazh Trust are now working intensely, as success in the installation and start-up of turbines, generators, pumps and all the equipment in the fourth 320,000 kW energy block depends upon them. This unit has a plate upon which is enscribed the name of the famous Elektrosila Electrical Machinery Building Association in Leningrad. S. Vedyukov, an engineer, is Elektrosila's representitive monitoring the course and quality of installation work. The plant plan for electrical equipment production in 1985 calls for building the fifth line of the same capacity for the Azerbaijan SSR. [By A. Belodubrovskiy] [Text] [Baku VYSHKA in Russian 13 Oct 84 p 2] 11574

GAS GRES--Three units of the Burshtyn GRES in Lvov Oblast have begun burning the "blue fuel". By the year's end the station will completely convert to the use of this fuel. [Text] [Moscow EKONOMICHESKAYA GAZETA in Russian No 39, Sep 84 p 3] 11574

GES ON ANGARA--The Angara's energy potential will be completely utilized after the construction of the Boguchanskaya GES, the fourth station in the cascade on this Siberian river. The 26th CPSU calls for beginning this station's construction in the 11th Five-Year Plan. Participating in the realization of these plans, specialists at the Elektrosila Association finished the draft designs for the station's hydroelectric generators. As LenTASS reports, the new, taiga "electricity factory" is to be equipped with 12 units of 333,000 kW each. The generators utilize most of the progressive design decisions used in recent years by this machinery building sector. [Excerpt] [Leningrad LENINGRADSKAYA PRAVDA in Russian 21 Sep 84 p 1] 11574

NEW POWER LINE--(Novosibirsk)--The 500 kV Sayano-Sushenskaya GES -- Novokuznetsk line will soon become "two lane". The Novosibirsk plant for ferroconcrete towers and pilings is ahead of schedule in fitting out the second circuit of the overhead line which will carry current produced by the Yenisey to enterprises in West Siberia. Together with electrical equipment installation workers, the enterprise collective is competing to overfulfill the target for the five-year plan's fourth year and honorably celebrate the 40th Anniversary of Victory. [By Lyakhov] [Text Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 7 Sep 84 p 1] 11574

NEW GENERATOR--The Elektrosila Association has shipped the last components for the ninth 640,000 kW generator at the Sayano-Shushenskaya GES. Enterprises and organizations participating in the Sayano competition have made the next to the last step in realizing their counter-plan; in the 11th Five-Year Plan they have completed the last two sets of equipment for our country's largest hydroelectric station. Tirelessly improving technology, introducing progressive equipment and increasing production intensity, specialists and workers have reduced the labor intensiveness of building the Sayano generators by 40 percent. [By Yu. Nikolayev] [Excerpt] [Leningrad LENINGRADSKAYA PRAVDA in Russian 28 Sep 84 p 2] 11574

NEW DC LINE--(Frunze)--The country's first high mountain DC power line has begun operation in Kirghizia. It connects the Tyuz-Ashyu Pass with the high valley of Susamyr, where large herds of livestock are kept on distant summer pastures. This is the first time that such a line has been built in mountains in the USSR. Eight lines are hung from each tower. What will be the effect from the new line? It will double the capacity of the electrical power supply system in Susamyr. The operational introduction of this line opens great prospects for installing DC lines in other inaccessible areas. Based on the experiences of Kighiz power engineering workers, plans are being worked out for a DC line on Sakhalin. It will reduce the costs of electric power supply to a large animal husbandry complex [Text] [Moscow SEL'SKAYA ZHIZN' in Russian 9 Sep 84 p 1] 11574

MANAGER REPRIMANDED--A group of workers at the Tsentrkazgeologiya [Central Kazakhstan Geological] Production Administration have written to the editors about deteriorating labor and production discipline and the reduced demands which the manager makes upon himself and his subordinates. They have listed cases of violations of mining operation rules, theft, and other negative phenomena. The facts mentioned in the letter were turned over to Gosgortekhnadzor [State Committee for Supervision of Safe Working Practices in Industry and for Mine Supervision] and the Kazakh SSR Ministry of Geology, where they were proven true. Yu. Terent'yev, deputy chairman of Gosgortekhnadzor answered the editors. Those guilty for the situation have been punished. N. Alimov, chief engineer of the Karaganda Geological Exploration Expedition was removed from his position for the unsatisfactory peformance of his obligations. N. Gutnikov, R. Kliko, the manager in charge of production and the labor production department, and other responsible persons at the Tsentrkazgeologiya Association were disciplined. By order of the Kazakh SSR Ministry of Geology, U. Yesentayev, the association's chief engineer, was reprimanded for not assuring the essential levels of production discipline and not protecting state property. [Text] [Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 12 Sep 84 p 2] 11574

CSO: 1822/40

PIPELINE CONSTRUCTION

DEPUTY MINISTER OUTLINES URENGOY GAS PIPELINE'S FUTURE PLANS

Moscow EKONOMICHESKOYE SOTRUDNICHESTVO STRAN-CHLENOV S E V in Russian No 3, Mar 84 (signed to press 27 Feb 84) pp 14-18

[Article by Deputry Minister Aleksey Sorokin, USSR Ministry for the Construction of Oil and Gas Industry Enterprises: "The Pipeline of Cooperation"]

[Text] "The construction Project of the Century," "The Super Pipeline" and "The River of Gas". These are not simply bright and catchy descriptions of the pipeline that connects tha gas fields of western Siberia with industrial centers of western Europe. They convey the uniqueness, greatness and magnitude of the project as well as its huge economic and political importance.

Using the slogan "Urengoy Gas for the World" Soviet construction workers began the construction of this gigantic artery to transport the "blue fuel." Their colleagues from other socialist countries are working side by side with them using the same slogan.

With this in mind, the editors asked Aleksey Sorokin, deputy minister of the USSR Ministry for the Construction of Oil and Gas Industry Facilities, Bogdan Bos', General Director of the Polish enterprise Energopol' and Yozef Odvarka, the representative of the Czech government concerned with the construction of the fourth line of the gas piepline to tell about what has been done along the pipeline route already and what plans there are for the near future.

The Pipeline of Cooperation

The 26th Congress of the CPSU called increasing gas recovery in western Siberia and transporting it to the European section of the country a main link in the long term energy program of the USSR. It is projected that 350 billion cubic meters of the gas will be obtained here in 1985, including 185 billion cubic meters in the Urengoy region. Urengoy is a store-house of gas which has no equal in the world.

The Biography of a Construction Project

The construction areas are characterized by harsh climatic conditions: swampy conditions, permafrost and sharp variations in yearly temperatures.

The first phase of the exploration of the Urengoy field dates back to the mid-60's. It was during this time that geologists discovered the first gas deposits at a depth of 1000-1200 meters. Subsequent exploration turned up a series of new deposits which contained condensate and oil as well as natural gas.

The development of the field began in 1975. In March, 1978 the first installation for the integrated processing of gas commenced operations. It had a production capacity of 10 billion cubic meters per year.

One may judge the size of this unique field and the scope of the construction-installation operations necessary for the development of this gas complex by the following data: to achieve projected capacity it is necessary to hook up about 1,300 producing wells, complete the assembly of 15 installations for gas treatment, make available almost 6,000 kilometers of gas collecting pipelines, and more than 900 kilometers of 1,020mm and 1,420mm lines between the gas recovery units.

I remind you that in accordance with directives of the 11th Five Year Plan adopted at the 26th Congress of the CPSU, six of the largest gas pipelines originating in Urengoy must be put into operation during the 1981-1985 period. Three of them were already started up during the first two years of the plan. The construction of line portion of the fourth, the Urengoy-Pomary-Uzhgorod export pipeline was begun in June, 1982 and completed in August, 1983.

All operations along the route of the line were mechanized with utilization of the most modern high productivity equipment and advanced technology. So that you can picture the scope of the job, I shall provide some figures: 2.7 million tons of pipe were delivered to the pipeline right-of-way; 2.1 million running meters of seams were welded; about 25 million square meters of pipe surface were covered with insulation; 128 million cubic meters of earth were excavated and moved, including 4 million cubic meters of rock; 27 million square meters of land were restored for cultivation; about 800 water crossings were built, including 21 large double pipelines across the Nadym, Ob, Chusovaya, Kama, Volga, Don and Dnieper rivers.

Collectives of 40 integrated production groups worked on the route. During the most hectic periods of the project as many as 20,000 workers were involved.

As is well known, an indisputable rule for the development of any new region is the utilization of an integrated approach, which provides for the realization of a systematic social program. This means that the major tasks of residential, cultural and other public facilities construction must be resolved at the outset. To achieve this goal a special unit

Glavzapsibzhilstroy (Administration for Residential Construction in Western Siberia) was set up. This organization provided cultural and other public facilities. The city of Novy Urengoy serves as a visible, tangible example. It is anticipated that between 100,000 and 120,000 will live there. Large residential complexes are going up along the whole route, first and foremost in areas where compressor stations will be operating.

It is in these very areas where construction emphasis has become greatest. 40 of these stations will be put into operation along the route. By January 1, 1984, 17 had already gone into operation. The construction of the remaining 23 has been planned for completion in 1984. Prime contracting organizations of five ministries are completing the job.

Gas-Pipes

As is known, the overwhelming majority of western European countries satisfy the largest part of their demand for natural gas by imports. According to data of specialists of the European Economic Community, the shortage of gas in western Europe might reach 130 billion cubic meters by the year 2000 even with maximum exploitation of domestic production and implementation of all existing contracts for the purchase of gas.

The long term cooperation of the Soviet Union with firms in the Federal Republic of Germany, Austria, Italy and France on a compensatory basis is convincing evidence of our country's strict observance of obligations it has taken upon itself for the delivery of natural gas. Therefore, the interest of many western European countries to substantially increase their imports of Soviet gas is understandable. This arrangement, the political importance of which is difficult to overestimate, is a great contribution to the struggle for peace and to the development of long term economic relationships between the USSR and western European countries. It serves the cause of mutual trust among countries both in Europe and beyond, and also is a serious factor in improving the political climate in the world. The Urengoy Pipeline reinforces the belief that in the final analysis all people win when detente is realized.

Such is the political side of the question. On the economic side, the construction of the export pipeline gives western Europe the opportunity of improving its fuel balance-sheet and the Soviet Union of receiving additional means for the even more dynamic development of its gas industry.

It is not accidental that economic and political steps were taken by the Reagan administration to wreck this most important undertaking. The announcement of an embargo, the unceremonious pressure on allies, and the prohibitions on the delivery of production equipment--all these sanctions were based on the belief that without western technology the USSR would not be able to build the pipeline--suffered a complete defeat. The actions of the White House evoked the angry condemnation of the Soviet people and strengthened their determination to complete the project, and to complete it more quickly.

At the initiative of a number of ministries and labor collectives of many industrial enterprises and construction projects, the above-plan production in 1983 of a large number of gas compressor units, 25 megawatt gas turbines and full-pressure boosters was successfully achieved. The production of gas pumping equipment (16-19 megawatts) based on an aviation engine was made possible. This permitted the equipping of compressor stations which came on line in 1983 with domestically produced units.

This proved anew that the Soviet economy has the strength to cope successfully with any large scale scientific/technical challenge.

The measures taken not only permitted us to fulfill our plans on time. They contributed to a situation which by the end of this five year plan will relieve us of the necessity of importing such equipment from capitalist countries. We must mention here the American newspaper THE WASHINGTON POST which wrote, "It is becoming ever more clear that the Reagan Administration not only tripped itself. While falling, it pushed the Russians ahead."

The delivery of Soviet gas to the countries of western Europe is the finale of this whole series of events. Deliveries began in 1984 on the basis of the contract entitled "Gas-Pipes," which is to run 25 years.

The contract is highly effective for our country also. It will make it possible to pump 21.5 billion cubic meters of gas into the USSR gas system every year.

With the Participation of Friends

This program of development, colossal in scope, of the earth's resources and of implementation of cross-country pipelines adopted in the Soviet Union has been greeted with enthusiasm in other socialist countries. Bilateral inter-governmental agreements have been signed and are being successfully implemented with the GDR, Poland and Czechoslovakia, which call for their participation in the construction of gas industry projects in the USSR during the 1982-1985 period. The same has been done with firms in Yugoslavia.

In accordance with the agreements, organizations in these countries will do a combination of jobs on the export pipeline dealing with the construction of sections of the line itself, the construction of eight compressor stations with all the necessary infrastructure for future operations personnel and also the construction of a large enterprise for the repair of gas turbine installations.

The conditions of cooperation provide for the Soviet Union to provide its partners with the basic production equipment, the pipe, stop valves, adapters, fittings and also welding and insulation materials.

The expenditures of these countries incurred in connection with their work at jointly agreed to projects of the USSR gas industry, as well as the delivery to the pipeline route of various types of their own domestically

produced products will be compensated by the export of additional quantities of natural gas from the USSR. The amount of gas will be based on a correlation of these expenditures and the price of the gas in place during the period when the inter-governmental agreements were signed.

Construction and assembly personnel from the GDR are working in Tambov Oblast (RSFSR) and Vinnitsa, Ivano-Frankovsk and Transcarpathian oblasts (UkSSR) on the construction of a 137 kilometer pipeline and four compressor stations: Staroyur'yevskaya, Barskaya, Bogorodchanskaya and Golyatinskaya, with micro-districts for housing operations personnel.

Those sent from Poland are working in the Transcarpathian Oblast in the UkSSR. They are also building the Romenskaya Compressor Station in Sumy Oblast, UkSSR with a set of infrastructure projects.

Yugoslav firms are doing a series of jobs at three compressor stations: Kungurskaya, Gorno-zavodskaya and Ordinskaya, all located in Perm Oblast, RSFSR.

Problems of an organization/technical nature as well as those dealing with the placement and coordination of the operations of the units of the individual countries which arise during the course of construction are effectively resolved thanks to experience acquired on the gas pieplines Bratstvo 1, Bratstvo 2, Soyuz and the oil pipeline Druzhba.

It was at these projects that principles of cooperation were worked out for application in joint construction ventures, and the great effectivenss of joining forces to solve large economic problems was proven. This is one of the reasons that attracted other socialist countries to the construction of the pipeline system Urengoy-Pomary-Uzhgorod.

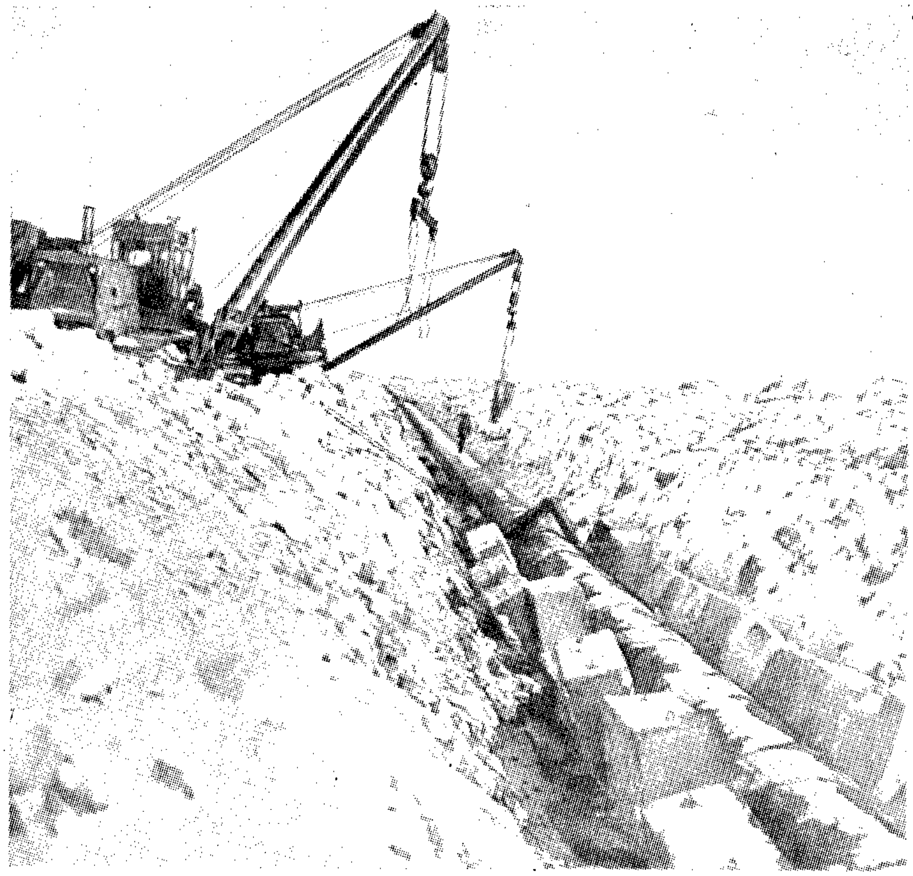
As provided for in the inter-governmental agreements with the GDR, Poland and Czechoslovakia and the agreements with Yugoslav firms, the Ministry of Construction of Petroleum and Gas Industry Enterprises, USSR performs the functions of the general contractor.

Senior management staffs of the contracting organizations from the CEMA countries and Yugoslavia are set up in cities located near the construction sites. To coordinate their activities and to insure effective cooperation, regional construction management groups of the all-union association Soyuzintergazstroy were formed.

During the pre-construction period temporary residential facilities were set up along with facilities to serve the everyday, medical and cultural needs of the workers. These facilities are movable and of prefabricated construction. The residential facilities have central heating, running water and provide all the necessary sanitary services. The personnel of the contracting organizations of the participating countries include qualified food service, medical and trade workers. In addition to residential facilities, production centers and unloading platforms have been set up at freight and equipment reception stations.

Coordinated meetings of responsible representatives of the participating countries are an important link in the management procedure. They are held quarterly and on a rotating basis at the various locations on the senior managements staffs and the field construction management groups. At the meetings, construction project managers' progress reports are presented, concrete steps are refined, and operations programs for the subsequent period are confirmed.

It is necessary to note also the activities which party committees, labor unions and Komsomol units from fraternal countries performed and which have contributed to fulfillment of the coordinated construction plans.



Laying the pipe

In summary, one must stress that the construction of the cross-country gas pipeline is yet another convincing example of mutually beneficial cooperation among countries with diverse social systems, and it serves as proof that countries and firms which want to support with us the principle of equal economic relations will always find us understanding and supportive. It also reconfirms with renewed force that the Soviet Union and the other socialist countries are capable of performing great tasks on the basis of highly effective cooperation.

SU-20 Mobile home settlement

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CSO: 1822/24

PIPELINE CONSTRUCTION

INTERVIEW WITH BOGDAN VOS', GENERAL DIRECTOR OF ENERGOPOL

Moscow EKONOMICHESKOYE SOTRUDNICHESTVO STRAN-CHLENOV S E V in Russian No 3, Mar 84 (signed to press 27 Feb 84) pp 18-20

[Interview with Bogdan Vos', general director of Poland's Energopol: "Energopol on the Right-of-Way"; no date or author indicated]

[Text] [Question] As we know, Poland is taking part in the construction of the export gas pipeline Urengoy-Pomary-Uzhgorod. Tell us please about the agreement itself and also about how construction is coming along.

[Answer] In June 1982 the governments of the USSR and Poland began discussions about the participation of Polish organizations in construction and assembly work on the Urengoy-Uzhgorod route. Both sides were interested in this. The Soviet Union got the opportunity to expand its gas delivery system without having to tap new capacities. Additional deliveries of natural gas, a raw material very necessary to Poland's economy, were guaranteed.

In view of the tight construction schedule deadlines, it was decided that the Polish organizations would take preparatory steps as quickly as possible, even before the detailed determination of terms and the signing of an agreement. In this regard the Polish government directed the minister of construction and the construction materials industry to immediately organize operations toward this end.

The job was entrusted to the management staff of Energopol in recognition of that organization's long-term experience in the construction of pipelines in the USSR. By December 1982 Energopol already had begun preliminary operations on the pipeline route. Social and everyday services projects, engineering projects, construction and transportation equipment inventory and worker recruitment received special attention. All this made it possible to meet work deadlines that were coordinated with the Soviet general contractor Soyuzintergazstroy.

The agreement on cooperation in the construction of pipeline projects on USSR territory during the period 1982-1985 was signed in Moscow on May 3, 1983.

[Question] On what sections of the pipeline are Polish workers working and what projects are they building?

[Answer] In accordance with the agreement we must put into operation the following projects in the Carpathians: two sections of the gas pipeline in the area of Uzhgorod (the end of the pipeline route in the USSR) with an overall length of 92 kilometers. Pipe diameter is 1,420 mm and operating pressure, 75 atm; the Romnenskaya Compressor Station with three 25 megawatt turbo-compressors; residential facilities for Romnenskaya Station's personnel.

[Question] How has Energopol utilized the experience that it gained at such projects as the oil pipelines Druzhba and Polotsk and the gas pipeline Soyuz?

[Answer] During the period 1975-1981 Energopol built a number of gas and oil industry projects including: a section of the gas pipeline Soyuz (584 km); the oil pipeline Polotsk-Birzhay-Mazheykyay (442 km); a section of the Surgut oil pipeline from Polotsk to Andreapol (300 km); four compressor stations on the gas pipeline Soyuz; seven compressor stations on pipelines in the Kharkov region; 11 pumping stations on oil pipeline routs and three storage fields for oil.

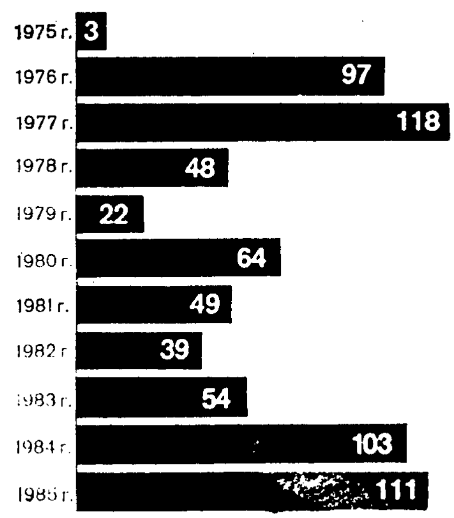


Figure 1. The volume of construction work that Energopol' has carried out in the USSR between 1975-1985 (in millions of rubles)

The experience accumulated by Energopol in previous work in the USSR is widely applied today in its work on the gas pipeline Urengoy-Pomary-Uzhgorod and related projects. The experience that we received building the third section of the Orenburg Gas Pipeline proved very valuable because we had

used there pipe of a diameter similar to that which we used on the line section of the cross-country pipeline. I would like to mention two of our achievements on the Orenburg job that have proved useful now: a continuous system of doing assembly work using two production lines, one for welding and the other for insulating and laying the pipe; and a unique way of doing hydraulic testing of the pipeline.

As far as compressor stations are concerned, the most interesting experience was that gained on the pipeline Soyuz and the gas pipelines in the Kharkov region. It is especially appropriate to note that assignments related to the carrying out of the contract are being handled by units of Energopol that have previoulsy worked in the USSR. What is more, in many cases the very same people, managers and even line workers, are on the job. This makes the organization of the job much easier and eases the stay of our collectives in the USSR. The effect of renewing cooperation with Soviet colleagues whom we have met on former jobs is very salutary.

[Question] How is work going now, and what are the prospects for the future?

[Answer] I remind you that work on the line portion of the pipeline Urengoy-Pomary-Uzhgorod was completed in August 1983, i.e., almost five months ahead of schedule. On that occasion a meeting among representatives of USSR, Polish and GDR collectives took place at a compressor station near the border.

Having finished building their section of the pipeline, the Polish workers started the construction of four compressor stations and subsidiary projects. At the same time they took up the construction of a 54 km leg of the cross-country pipeline which extends to the border of the USSR and Hungary.

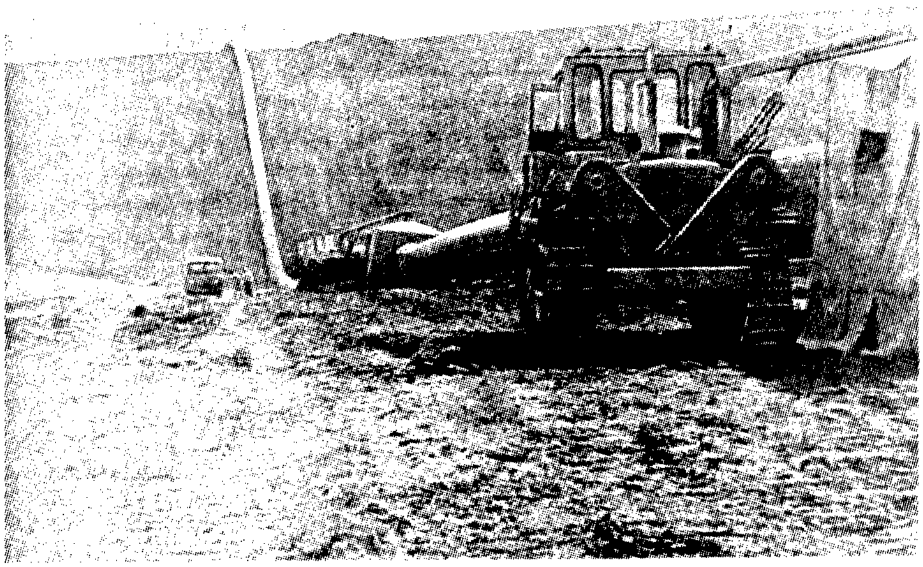
There is still one important project that we must put into operation according to the agreement. This is an underground gas storage facility in the city of Bogorodchany. We also have to complete a 14 story building in the city of Sumy and number of infrastructure projects.

Energopol plans for the near future center on fulfilling the May 3 1983 agreement, which provides that we complete work worth 181.5 million rubles. Among other projects included in the agreement, the gas pipelines Kobryun-Brest and Brest-Warsaw (construction of the latter, which we must begin in 1984) have special importance for the Polish economy.

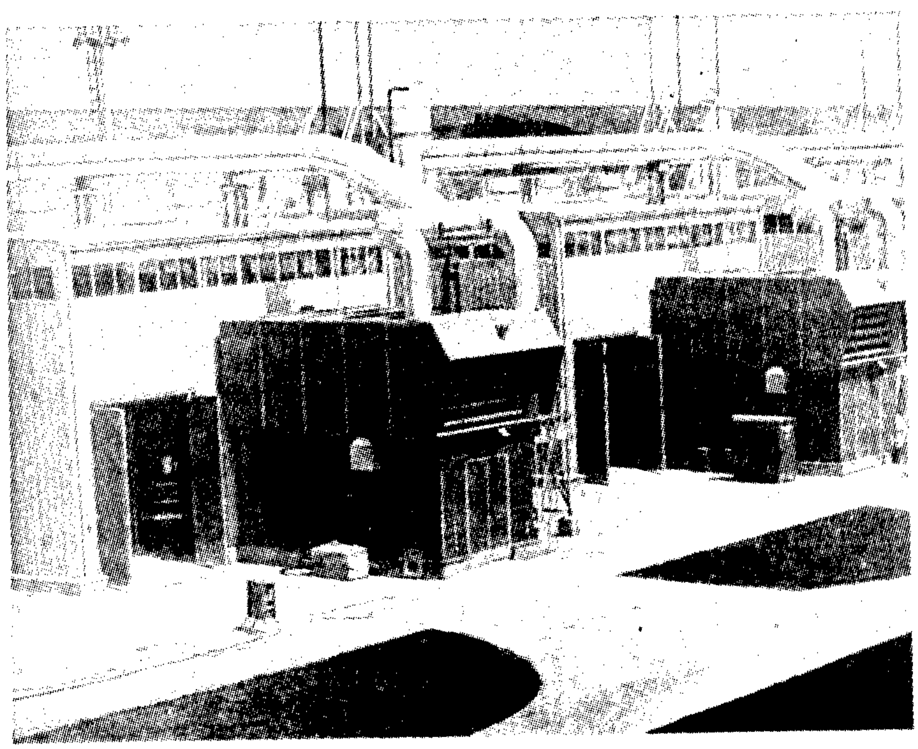
Our participation also in the construction of three nuclear power plants at Khmelnitsky, Kursk and Kharkov and of oil pipelines in the Soviet Union will continue.

We are now developing proposals for the construction in the USSR of other projects, which is in line with the expansion of our mutually beneficial cooperation.

[Question] In which Polish industries will Soviet gas be used?



Pipe-welding gang on the right-of-way



Compressor station

[Answer] As a result of our construction of a section of the Urengoy-Pomary-Uzhgorod pipeline and the completion of attendant work, Poland gains the right to purchase in the USSR quantities of natural gas over and above those established in existing trade agreements. To express it more concretely, for our participation in the completion of the Urengoy project, we shall receive two billion cubic meters of natural gas over five years 1986-1990 or 400 million cubic meters per year.

This will permit us to improve Poland's fuel-power generation balance and to use Soviet gas in metallurgy, the chemical industry (especially to produce artificial fertilizer) and in the public sectors of the economy.

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PIPELINE CONSTRUCTION

CZECHOSLOVAKIA'S JOSEF ODVARKA ON 4TH PIPELINE SECTION

Moscow EKONOMICHESKOYE SOTRUDNICHESTVO STRAN-CHLENOV S E V in Russian
No 3, Mar 84 (signed to press 27 Feb 84) pp 21-23

[Interview with Josef Odvarka, CSSR plenipotentiary for the construction of the 4th section of the pipeline: "A Steel Bridge into Europe"; no date or author indicated]

[Text] [Question] Today 37 billion cubic meters of natural gas are being transported across the territory of Czechoslovakia en route to other European countries. How much will the transmission capacity of Czechoslovakia's pipeline system grow as a result of its participation in the Urengoy project?

[Answer] On July 1, 1982 the USSR and Czechoslovakia signed an intergovernmental agreement dealing with the expansion of Czechoslovakia's transit pipeline system and intended to ensure deliveries of Soviet gas to Europe. On the basis of the agreement the capacity of our transit system must grow from 37 billion cubic meters per year to 68 billion cubic meters in 1989. Of this quantity, exports to Western European countries will rise from 23 billion to 50 billion cubic meters per year.

In order to process this great flow, new capacity and technology are needed. Here is just one example: if formerly, six megawatt gas engines operated at compressor stations, their productivity on the fourth line will be 25 percent greater.

As far as the line portion of the pipeline is concerned, for the first time in Czechoslovakia 1,400 mm diameter pipe and operational pressure of 75 atmospheres are being used. It is also planned to put into operation three compressor stations equipped with seven compressors with an overall motor drive capacity of 175 megawatts. The border transmission station at Velikiye Kapushany is being expanded. After its reconstruction and modernization a new system of operation tied in with a control center in Prague will commence to function.

The fourth line of the transit pipeline in Czechoslovakia is an organic extension of the system of gas pipelines in the USSR set up at the new fields in western Siberia. Insofar as this new route has important political and

economic significance, Czech party and state bodies and also construction and assembly organizations responsible for the construction of this technically complex project are devoting much attention to it.

Given the experience and initiative of the workers, we are confident that the tasks before us will be completed on schedule and in a quality manner.

[Question] Please tell us in more detail about this route.

[Answer] The fourth line of the transit system will run parallel to the eastern section of the gas pipeline.

The overall length of the line is approximately 850 km. It will run from the Soviet border, i.e., from Velikiye Kapushany, through Plavetsky Petr and Brzhetslav to Rozvadov on the border with the Federal Republic of Germany; it will traverse six oblasts and 24 districts of our country.

In view of the great scale of construction along the route and the diversity of the topography, the line will cut through a thick network of communication lines and water structures. Inasmuch as the compressor stations are being built where there are existing operating stations, there will be no need to take additional agricultural lands out of production. And there is yet another plus: it will be possible to utilize existing equipment with maximum efficiency.

The prime contractors for the construction of the fourth line are the enterprises Gidrostav Bratislava and Plinostav Pardubitse, both known throughout the world. They know well the topography of the area and they distinguished themselves in previous phases of the operations.

[Question] As is known, during the construction of the first lines of the gas pipeline much good use was made of the experience and achievements of the USSR. High-productivity Soviet equipment was supplied to the project. What role does all this play during the present phase?

[Answer] During the construction of the first projects on the transit pipeline, the Soviet Union supplied us with the basic construction vehicles and machinery. In addition, we received from the Soviet Union about 211,000 tons of 1,200 mm diameter pipe that was purchased from the firm Mannesmann (the Federal Republic of Germany).

The USSR also rendered much technical help to us. Soviet specialists were sent to Czechoslovakia in order to solve especially complex problems. Their help in designing various projects was significant. We were provided with blueprints and technical data for compressor stations and licenses for the manufacture of turbo-compressors. Our specialists and builders have visited the USSR to work with and to learn from their Soviet counterparts. Our contacts with the Institute of Electric Welding imeni E. O. Paton in Kiev were especially useful for us.

This comprehensive help has been very valuable to us. It did enable us, lacking experience at the outset, to construct the first lines of the gas system in a most rapid manner. However, that was not all, because it played a decisive role in our acquisition of new professions.

The first of these professions is that of gas pipeline builder. Today, the quality of this work, especially pipe seam welding, in our country is above the world standard. A great number of qualified workers, accredited to work on seams, are at work at our enterprises. In the city of Pardubic a special training school preparing welders is in operation.

The second is that of machine builder. Machine builders produce various equipment for the gas pipeline. We previously discussed one type of equipment: powerful, gas engines, production of which is licensed by the USSR. The manufacturer and the supplier of this new unit is the experimental plant of the firm ChKD-Prague. Here, synchronous electric motors with smooth control capability are being developed and are being equipped with these engines.

In order to provide the project with the latest equipment, other Czech enterprises are participating. Sigma, for example, will send here automated control systems; Paketokabel', electrical equipment and remote control equipment for gas transfer stations, etc. Agreements have already been concluded with parts suppliers' collectives to make deliveries ahead of schedule.

[Question] What has been completed on the route up until now, and what plans are there for the near future?

[Answer] Of the pipe's overall 850 km length, the so-called southern 440-km long section will be completed during the period 1983-1985. It will run from the junction in Plavetsky Petr to the Czech border with the Federal Republic of Germany.

Construction work commenced here in January 1983. The pace of pipe laying has been very rapid, 9-10 km per month by each of the Transgas units. As a result, by the beginning of 1984 about 200 km of the line was laid and welded. This means that during this year and the beginning of next year another 240 km must be constructed.

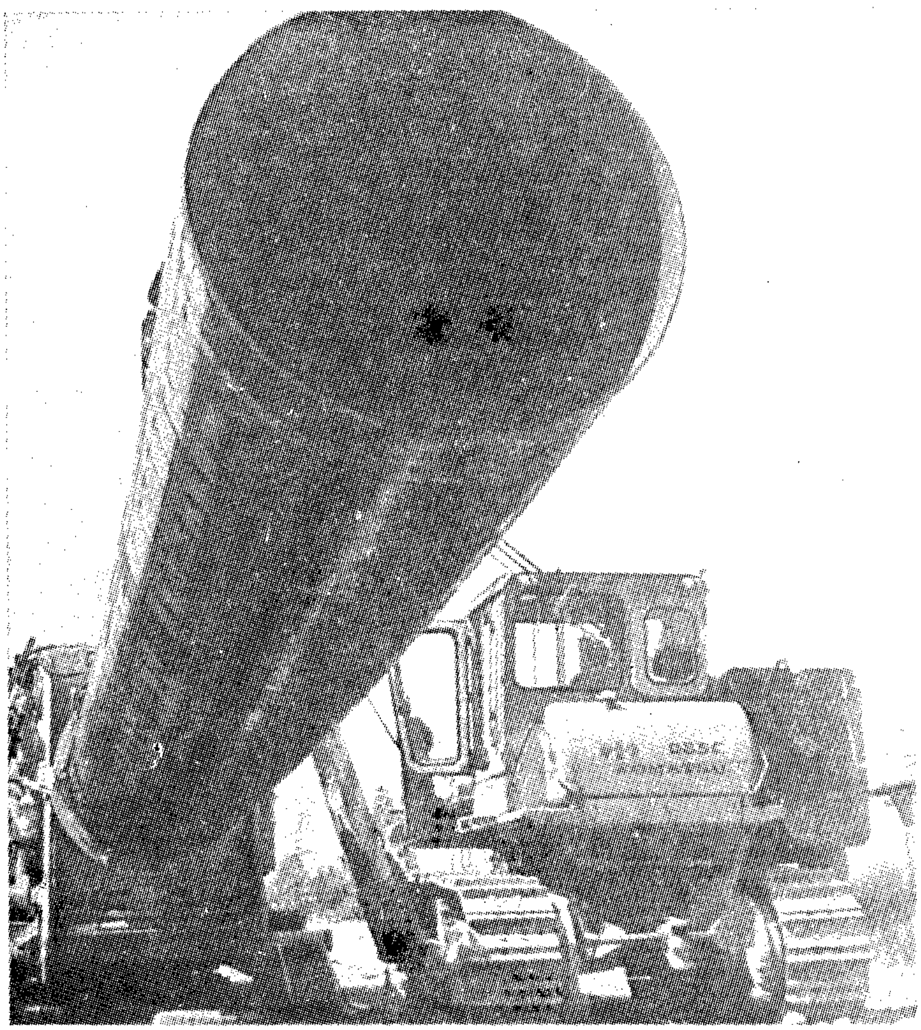
In 1985, work will also be done on the eastern section. This section runs from the USSR border to Plavetsky Petr. Its length is about 410 km. By the end of 1986, 200 km of the route will be put into operation; the remaining 210 km, by the beginning of 1988.

Such is the status of the line portion of the gas pipeline today, and what it will be tomorrow. A great amount of work is planned in the construction of compressor plants. The plants in Velikiye Kapushany and Brzhetslav are planned for operation by 1 January 1987 and in Veseli and Luzhnitsy by 1 January 1989.

Czechoslovakia will also participate in the construction of one of the pipeline projects in the USSR, the central repair base in Uzhgorod.

[Question] How will the shipment of gas across the territory of Czechoslovakia be paid for?

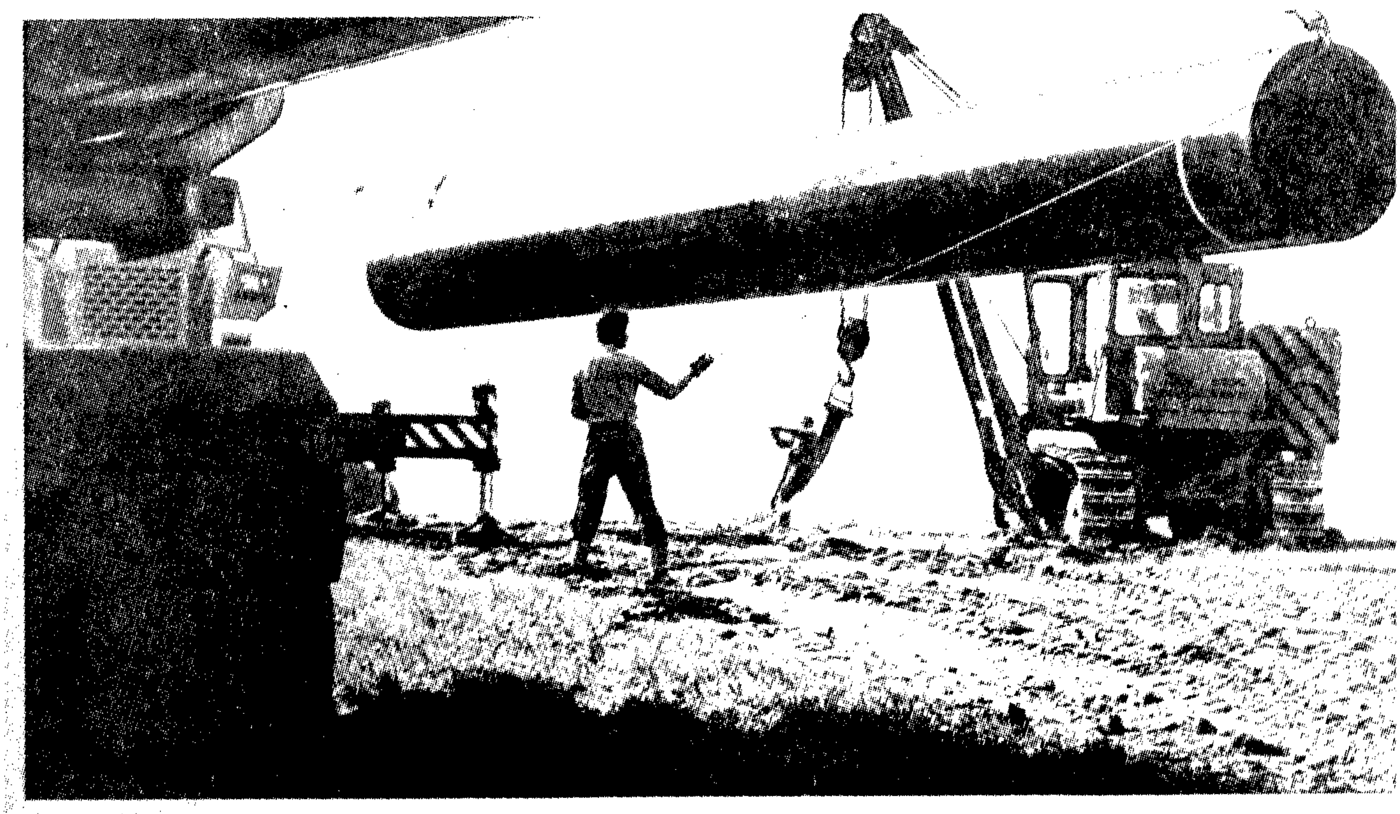
[Answer] This payment is defined by contracts between the external trade organizations Metalloimpeks (Czechoslovakia) and Soyuzgazeksport (USSR). It is related to the amount of gas shipped to the Czech border with the Federal Republic of Germany and to the Czech border with Austria. In 1983, for example, we received, thanks to these shipments, three billion cubic meters, which is 30 percent of the natural gas shipped to Czechoslovakia from the USSR.



Delivery of pipe to the right-of-way

The parties will proceed from the same principle, the volume of transported gas, when determining payment for the transportation of gas along the 4th section of the pipeline.

In conclusion, I would like to note that the importation of natural gas from the USSR contributes substantially to the development of the Czech economy. Cooperation with the Soviet Union will make it possible for us to supply various sectors of our industry and our agriculture with this valuable raw material and fuel, to expand its use in the community and domestic economy of our larger cities, Prague, Bratislava, Ostrava, Brno and others, and at the same time help to resolve important ecological problems.



On a section of the 4th Pipeline Section

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COMPRESSOR STATIONS

UDC 621.532.2

FUEL GAS HEATING IMPROVES GAS COMPRESSOR OPERATION

Kiev NEFTYANAYA I GAZOVAYA PROMYSHLENNOST' in Russian No 3, Jul-Sep 84 pp 43-45

[Article Yu. N. Vasil'yev and Yu. A. Boboshko, All-Union Scientific Research Institute of Natural Gas, and Kiyevtransgaz Production Association: "Fuel Gas Heating and Reliability of Combustion Chambers of Gas Compressor Units"]

[Text] On the whole, the reliability of gas compressor units depends on the operating liability of the combustion chamber. Faults and defects in the combustion chamber arising in the course of operation of the gas compressor unit lead to unavoidable shut-downs of the unit, and they decrease the life of turbine vanes in gas turbine compressor units, and of the piston-and-cylinder group of piston compressor units.

Let us examine the basic defects of combustion chambers and the effect of heating fuel gas prior to its combustion as a means for correcting such defects.

The most widely encountered operational defect of gas compressor unit combustion chambers is formation of carbon deposits on the face of the injector nozzle. This shortcoming is typical of the GT-750-6 and GTK-5 units. When fuel gas emerges from the injectors, droplets of hydrocarbon condensate and mechanical particles are caught by the reverse flow, and they settle on the front surface of the injector nozzles. High temperatures coupled with the lack of air cause thermal decomposition of condensate droplets, resulting in formation of a carbon deposit which disturbs the normal work of the combustion chamber.

This defect is easily eliminated by heating the fuel gas prior to burning, at least to a temperature of 100°C. Thus deposits do not form in units of the Lubna compressor station, where fuel gas is heated to a temperature of 200-300°C.

It is important to avoid incomplete combustion of gas to insure normal operating conditions in the combustion chamber. Losses resulting from incomplete gas combustion increase fuel consumption, and consequently decrease the economy of the gas turbine unit.

In the case of physical underburning fuel that does not have a change to burn within the chamber is carried out of it together with gases; it then burns at the turbine vanes, reducing the turbine's life and causing emergency shutdowns. Physical underburning is also manifested as formation of deposits on turbine vanes, which causes their mechanical erosion. Chemical underburning leads to wear of the heat-receiving surfaces of the regenerator. This pertains in particular to natural gas containing hydrocarbon condensate. Not having a chance to burn in the combustion chamber, minute droplets of natural gas burn within the turbine's deflecting unit, causing its premature wear.

Not all condensate droplets settling in the combustion chamber evaporate in the front section: Some large droplets continue to evaporate in the combustion zone in response to growing temperature and the rate of flow. The quantity of unvaporized fuel and the rate of evaporation of droplets in the combustion zone influence the development of combustion and the amount of physical underburning. According to calculations made by Raushenbakh [1] it is very difficult to vaporize droplets in the combustion zone owing to the high rate of flow of the gas. Therefore to avoid physical underburning it would be desirable to select, on the basis of flow and fuel parameters, conditions permitting completion of droplet evaporation primarily before the combustion zone.

This defect is easily corrected. When gas is heated to 200-200°C before entering the combustion chamber, vaporization of condensate in fuel gas occurs completely within the heater-heat exchanger. Vaporized fuel gas condensate is a homogeneous mixture, and it does not worsen the combustion process--on the contrary the products of its initial thermal decomposition are active centers for development and occurrence of chain reactions of natural gas combustion.

The defects examined here may be corrected in the course of operation by raising the intensity of the combustion process.

In combustion chambers in which gas and air are fed in separately, carburetion must be accelerated in order to raise the intensity of gas combustion. Intensification of combustion of gaseous fuel is promoted by an increase in the rate of propagation of the flame and by creation of conditions providing for significant development of the burning surface. The rate of combustion increases with growth in flame temperature. Ignition of fuel gas may turn out to be the bottleneck in the search for ways of intensifying the combustion process, since by its nature, flame burning is a process characterized by limited ignition.

The following can be recommended as ways to intensify gas combustion:

1) achieving maximum possible temperatures during combustion by preheating the combustion components and using a small air-fuel ratio;

2) raising the degree of turbulent flow of the fuel mixture, which would increase the rate of propagation of the flame;

3) increasing the surface of the combustion front by breaking down a single flame into a number of small ones;

4) promoting stable ignition of the fuel mixture in the flow by using special ignition stabilizers, by achieving intensive mixing of the fuel mixture with hot combustion products and by forcing combustion products to the root of the flame and by having the flame come in contact with heated ceramic surfaces;

5) improving mixing of fuel and oxidizer by installing a gas-operated ultrasonic generator in the combustion chamber.

One of the simplest methods of raising the intensity of combustion during operation is to heat the fuel gas to a temperature on the order of 300°C before it enters the combustion chamber.

Let us dwell on the effect preheating of gas has on spray combustion of natural gas. During operation of gas turbine gas compressor units, the flame must be characterized by high kinetic energy, which is determined by the quantity and parameters of gas and intensifiers--compressed air, oxygen, steam and the vapor phase of hydrocarbon condensate. Special requirements are imposed on the mixing of fuel with air and on preparation of fuel for combustion.

A faster gas outflow rate promotes intensification of combustion in the initial section of the flame, while raising the temperature of its root section promotes intensification of heat exchange between the flame and secondary air. Inasmuch as heat exchange in the working space of the combustion chamber occurs predominantly due to radiation, an increase in the temperature of individaul sections of the flame raises the average difference in temperatures between the flame and secondary air fed in beyond the root section of the flame.

Research shows that combustion chambers work most productively when the maximum temperature of the flame is near that of the burners. Therefore intensification of heat evolution in the initial section of the flame promotes a rise in the productivity of the combustion chamber.

Aerodynamic characteristics of the flame--coverage, stability and mean mass flow in the working space of the combustion chamber--are determined primarily by the parameters and consumption figures of gas, compressed air and steam fed to the root of the flame, since the velocity of regenerating air at the input into the working space of the combustion chamber usually does not exceed 10-15 m/sec. Therefore to maintain these flame parameters at their optimum level, if gas consumption decreases, the rate of outflow of the other components that form the flame must be increased.

The suitability of using water vapor as an intensifier of natural gas combustion has been widely discussed in recent years. Use of steam is known to reduce the temperature of the flame by 25-40°C, and to have a negative influence upon formation of nitric oxides in the flame. However, the rate of outflow of steam from Laval's nozzle at an initial pressure of 13 atm and

a temperature of 360°C is 1,040 m/sec, in view of which direction of such a high-energy flow into the root of the flame promotes growth of its stability and coverage, thus promoting improvement of fuel combustion and heat evolution, which positively affects the productivity of the combustion chamber.

The energetically most feasible way of raising the aerodynamic characteristics of the flame is to raise the pressure and especially the temperature of natural gas prior to combustion. Preheating of high-pressure natural gas has great significance to raising the rate of its outflow from the burner nozzle. This question was approached in former times only from the standpoint of the quantity of working heat carried into the working space together with the flow of one substance or another. Inasmuch as mass consumption of gas is about 6-7 percent of mass consumption of air, the physical heat of gas in the overall fuel balance of the working space of the combustion chamber does not exceed 2 percent, even if it is heated to 500-600°C (in our case, where it is heated to 300°C, it does not exceed 1.5 percent). However, preheating of the gas may have significant influence upon the aerodynamics of the flame.

Raising the initial temperature of gas at a pressure on the order of 3-5 atm promotes not only growth in the rate of outflow of the gas but also acceleration of thermal decomposition of hydrocarbons in the flame. We can achieve optimum conditions for thermal decomposition of methane or get the closest possible to them by creating conditions permitting thermal decomposition of gas in the flow within the working space itself.

High-temperature preheating of natural gas in a recuperative gas-type heater makes it possible to reform gas into a high-velocity jet of sufficient power while simultaneously reducing gas consumption significantly and raising the temperature of the flame.

Six fuel gas heaters developed by Boboshko and Polishchuk have already been installed at the Kiyevtransgaz Production Association. Fuel gas is heated prior to the combustion chamber by gases discharged from a low-pressure turbine. This promotes reduction of fuel gas consumption owing to intensification of the cracking of hydrocarbons (especially heavy hydrocarbons and condensate, which are necessarily found in gas), better mixing of fuel and oxidizer, intensification (owing to creation of free radicals) and stabilization of combustion, equalization of the temperature field before the high-pressure turbine, reduction of gas underburning, exclusion of pulsed burning, equalization of operating conditions and growth in the life of turbine vanes [2].

It should be noted that failures associated with coking of burners completely disappeared and gas fuel consumption dropped by 50 m^3/hr in gas compressor units equipped with heaters.

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